Towards a Theory on the Design of Adaptive Transformation: A Systemic Approach

A Monograph

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14. ABSTRACT
This work proposes a novel approach to military transformation, 'Adaptive Transformation,' that accounts for an inescapable reality in the current and future operational environment: *uncertainty*. Military planners and decision makers have to face long-term, evolutionary, and transformational changes under two major premises. First, military transformation needs to be conceptualized as a continuously evolving, self-adapting process. Second, the terms that define its desired end state need revision, as the quest for an unequivocal, well-defined end state can derail the process. 'Adaptive Transformation' benefits from complex systems theory and principles of the Art of Design. A systemic approach to tackle military transformation through the lens of complexity offers a useful intellectual approach to address transformational issues. Moreover, the Art of Design provides a methodology that seems ideally suited to tackling the complex, ill-defined problems that military transformation embodies.

A theory on the design of military transformation helps address the military planner's dilemma. An 'Adaptive Transformation Cycle', based on four cognitive spaces, encompasses at the institutional level the inner 'Adaption Cycle' that functions at the operational level. Both processes are complementary and self-reinforcing in nature, with the former providing a higher level of adaptation informed by design. The fourth cognitive space, the 'engagement space,' gives meaning to this construct, as it represents the institution's ongoing physical and cognitive interaction with the environment.

This research ends with several conclusions on the application of complexity theory and the Art of Design to military transformation, and some recommendations for military planners involved in transformational issues. Adaptive Transformation is the proposed intellectual and operational approach to adequately address Armed Forces' evolution in the 21st century.

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Abstract

TOWARDS A THEORY ON THE DESIGN OF ADAPTIVE TRANSFORMATION: A SYSTEMIC APPROACH by MAJOR Luis Francisco Cepeda Lucas, Spanish Army, 73 pages.

Military transformation dominated the defense debate at the turn of the century. *Transformation* became the buzzword to define the radical, comprehensive change that senior leaders in both the Department of Defense (DOD) and the U.S. Army envisioned. These organizations heartily embraced transformation as the desired approach to face the anticipated future challenges and threats of the 21st century. Many Western armies mirrored this model. Nevertheless, U.S. military transformation is a concept currently blurred and emptied of its original meaning; it has become just an extension of the Revolution in Military Affairs (RMA) due to an overreliance on the technological domain.

This work proposes a novel approach to military transformation, 'Adaptive Transformation,' that accounts for an inescapable reality in the current and future operational environment: *uncertainty*. Military planners and decision makers have to face long-term, evolutionary, and transformational changes under two major premises. First, military transformation needs to be conceptualized as a *continuously evolving, self-adapting process*. Second, the terms that define its *desired end state* need revision, as the quest for an unequivocal, well-defined end state can derail the process. 'Adaptive Transformation' benefits from complex systems theory and principles of the Art of Design. A systemic approach to tackle military transformation through the lens of complexity offers a useful intellectual approach to address transformational issues. Moreover, the Art of Design provides a methodology that seems ideally suited to tackling the complex, ill-defined problems that military transformation embodies.

A theory on the design of military transformation helps address the military planner's dilemma. An 'Adaptive Transformation Cycle', based on four cognitive spaces, encompasses at the institutional level the inner 'Adaption Cycle' that functions at the operational level. Both processes are complementary and self-reinforcing in nature, with the former providing a higher level of adaptation informed by design. The fourth cognitive space, the 'engagement space,' gives meaning to this construct, as it represents the institution's ongoing physical and cognitive interaction with the environment.

This research ends with several conclusions on the application of complexity theory and the Art of Design to military transformation, and some recommendations for military planners involved in transformational issues. First, the strategic and political decision levels are the authentic realm of design; incorporation of Art of Design at institutional level, far beyond its operational applications, will enhance senior leaders' understanding and decision making processes. Second, military transformation needs conceptualization as a continuously evolving, self-adapting process to effectively implement those changes that transformation demands. Third, the 'engagement frame' in which the Adaptive Transformation process interacts with the environment and receives feedback requires close scrutiny and development. Fourth, the terms to define transformation's desired end state need revision; a 'good solution' in the form of a zone of tolerance or acceptable end state is preferable to an 'optimal solution' that becomes unachievable in the long run. In sum, Adaptive Transformation is the proposed intellectual and operational approach to adequately address Armed Forces' evolution in the 21st century.

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Introduction

The transformation of the U.S. military became the major Department of Defense (DOD) priority for the Bush administration that took office in January, 2001. For the recently appointed Secretary of Defense, Donald Rumsfeld, the transformation of the DOD was the principal endeavor, according to the presidential intent announced during the electoral campaign.[1] Even before, in October 1999, the Chief of Staff of the Army, General Eric Shinseki, had announced his intent of radically transforming the U.S. Army towards the Objective Force, which would entail profound consequences for the overall institution in decades to come.[2] Consequently, *transformation* became the buzzword to define the radical, comprehensive change that senior leadership in both the Department of Defense (DOD) and the Department of the Army (DA) envisioned for the U.S. military. The aim was to design and implement the desired military capabilities by the 2020s.

In recent years, most Western countries have also committed to transform their military establishments towards the types of force structures required to face likely challenges in a 10 to 20-year time frame. This military transformation proposes radical changes in all aspects that constitute a military system. Specifically, the domains of doctrine, organizations, training, materiel, leadership and education, personnel, and facilities (abbreviated DOTMLPF by the DOD) are considered within the scope of transformation. Nevertheless, a myriad of variables which hinder achievement of the desired end state as initially defined have an influence on this overarching transformational process. The 9/11 attacks and subsequent U.S. commitment to the

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[1] In September 1999, the presidential candidate at that time, George W. Bush, outlined in The Citadel the basic guidelines for a comprehensive military transformation when in presidency. He referred to transforming the military as a "massive undertaking" that would require "challenge the status quo and envision a new architecture of American defense for decades to come." http://www.citadel.edu/pao/addresses/pres_bush.html (accessed Nov 18, 2009)

[2] General Shinseki first publicly announced the transformation in a speech before the 45th Association of the United States Army (AUSA) annual meeting, on October 12, 1999, shortly after his appointment as Army Chief of Staff.

global war on terror, with counterinsurgency strategies that demand protracted manpower-intensive deployments in Iraq and Afghanistan, had a drastic influence on the original transformation plans. Moreover, some recent DOD political decisions cancelling flagship transformation procurement programs –notably the Army Future Combat System (FCS) – seem to invalidate the initial transformational model, if not completely, at least substantially.[3] There appears to exist an *operational pause* in the transformational process, awaiting reinvigoration or, maybe, thorough redefinition.

The Art of Design, conceived as a problem solving methodology to cope with complex situations, may potentially contribute to the definition and implementation of a renewed military transformation process. In the last five years, the School of Advanced Military Studies (SAMS) within the U.S. Command and General Staff College (CGSC) has gained broad experience in the development of this methodology to support complex problem solving in the operational arena. Nevertheless, expanding the design approach to other institutional areas beyond operational design deserves scrutiny. Design methodology, suited to provide systemic responses to ambiguous, ill-defined complex problems and environments, is of value to help address the complexity of a military transformation process, while maximizing the possibilities of complex systems science. Once the Armed Forces are categorized as a complex system, and the need for an understanding of the multiple variables involved in defense policies towards a future force is recognized, there is potential for the application of design methodology to both define and implement a military transformation.

There are valuable lessons and experiences that can be gleaned from a study of the dynamics and evolution of the U.S. military transformation and the potential application of the

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[3] Kris Osborn, "FCS Is Dead; Programs Live On U.S. Army To Dissolve Flagship Acquisition Effort", *Defense News* (18 May 2009) http://www.defensenews.com/story.php?i=4094484 (accessed February 02, 2010). See also Christopher Drew, "Military Budget Reflects a Shift in U.S. Strategy", *The New York Times* (April 6, 2009) http://www.nytimes.com/2009/04/07/us/politics/07defense.html?_r=3&hp (accessed February 02, 2010)

Art of Design. The U.S. transformational process developed a model that has served, and still serves, as an inspiration for similar processes in many Armed Forces throughout the world. Thoroughly documented, it represents an excellent case study to identify and analyze the potential use of the design methodology, and provides a valuable learning opportunity for other armies involved in military transformations.

The purpose of this work is twofold: first, to provide insight on the development and current status of U.S. military transformation from the perspective of complex systems science and design methodology; and second, to elaborate a theory on the potential application of design to define and implement an Armed Forces' transformational process. In doing so, this research would contribute to the exploration of design methodology at SAMS, while expanding the potential application of the Art of Design to other institutional fields apart from the operational arena.

What is *not* "military transformation"?

The use of the term *transformation* in reference to substantial changes in a military organization has spread widely in the last decade. The Bush administration led the way in 2001, as it mandated military transformation as the main DOD undertaking for the following years. Since then, not only have many Western nations, but also relevant security organizations such as NATO, embraced this concept to define their attempts to adapt military organizations to new challenges and missions.[4] Nonetheless, there is a lack of consensus on its real meaning and scope. Frequently the world *transformation* used in a loose manner, the lack of rigor in attributing transformational characteristics to what may be better described as routine modernization

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[4] In the 2002 Prague Summit, the North Atlantic Treaty Organization (NATO) decided a comprehensive reorganization of its command structure. One of its two strategic commands, Strategic Allied Commander, Atlantic (SACLANT), converted into the *Allied Command of Transformation* (ACT), with a strategic objective in "Lead NATO military transformation." www.act.nato.int (accessed Nov 15, 2009).

processes has converted the term transformation into "a generic buzzword for ill-focused change."[5]

This conceptual confusion has a close precedent in the 1990s, with the introduction of the term Revolution in Military Affairs (RMA). Andrew Marshall, head of the Office of Net Assessment, first introduced this concept in 1993. The RMA's intellectual origins were rooted in the concept "military-technical revolution" (MTR), developed in the Soviet Union in the late 1970s. Military analysts in the USSR began to identify a MTR through the use of computers, space surveillance, and long-range precision missiles. The RMA widened the MTR principles to include more than technological advances, incorporating new doctrine and organization approaches. Andrew Marshall, sometimes called the father of the RMA, elaborated on this concept before the Senate Armed Services Committee in May 1995, where he referred to the RMA as "[f]undamental, far-reaching changes in how advanced militaries either plan to conduct, or actually prosecute, military operations."[6] Thus, although many defense analysts in the U.S. and abroad routinely identify the RMA concept just with the use of emergent information technologies for military purposes, according to Marshall's ideas the sole application of new technologies would not suffice to implement the RMA,

Taking a wider perspective, military transformation would represent only the latest in a list of interrelated, consecutive terminologies that have appeared over the past few decades to describe changes underway in Western militaries. The progression began with the Soviet MTR in the 1980s, then proceeded to the U.S. RMA in the mid and late 1990s, and finally made the rhetorical transition to military transformation around the turn of the century, especially after

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[5] Elinor Sloan, *Military Transformation and Modern Warfare A Reference Handbook* (Westport, CT: Praeger Security International, 2008), vii.

[6] Ian Roxborough, "From Revolution to Transformation: The State of the Field," *Joint Forces Quarterly* (Autumn 2002): 69. Page 71 includes a quote from Marshall's testimony before the Senate Armed Services Committee: "Innovations in technology make a military revolution possible, but the revolution itself takes place only when new concepts of operations develop, and, in many cases, new military organizations are created."

Donald Rumsfeld became Secretary of Defense in early 2001. Transformation had superseded the RMA as a more comprehensive concept. Figure 1 represents a conceptualization of the expanded scope of these terminologies in terms of concentric circles:[7]
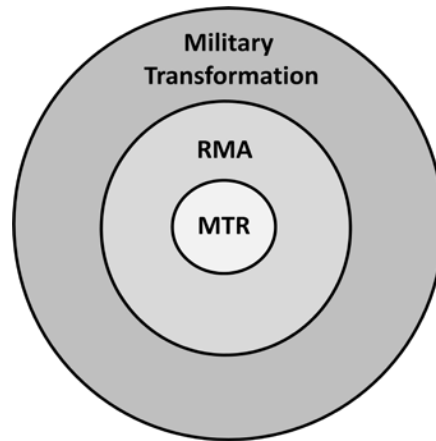
Figure 1. MTR, RMA and Military Transformation as build-up concepts.

Nevertheless, there are reasons to question the authentic transformational quality of the changes that the U.S. military announced and implemented at the turn of the century. As this work demonstrates, this transformation represents just another chapter of the RMA initiated in the mid-1990s, with a heavy reliance on technological aspects. Some changes in other aspects of the DOTMLPF domain have undoubtedly occurred in the last years, notably the U.S. Army's adoption of the modular concept. But the authentic military transformation that would enable the U.S. Armed Forces to face the challenges of the 21st century is still pending definition.

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[7] Sloan, *Military Transformation and Modern Warfare,* 1. The author refers to a possible conceptualization of those terms as concentric circles, page vii: "When thinking about the military technical revolution, the RMA, and military transformation, it is useful to conceive of a series of *concentric circles*, each progressively more expansive but each continuing to encompass the earlier core or cores."

Transformation in an organization implies changes that go far beyond mere modernization, as the former would incorporate new equipment, tactics, and doctrine.[8] While modernization relates to *evolutionary* change, transformation is the realm of *revolutionary* change. The focus has to be on a clear definition of the "ends," which makes it different from other reengineering, downsizing, and rightsizing processes that focus on "ways" and "means."[9] Nevertheless, it is not viable to determine the ends that have to guide the whole process in absolute, unequivocal terms. Are we ever really able to define the desired conditions in absolute terms when considering processes in a 15 to 20-year horizon? We can conclude that there is a need to define the terms and conditions of a real military transformation far beyond the scope of the RMA. This transformation has to tackle the uncertainties of a continually changing environment, with an increasing number of actors and interdependences that heavily influence the process. In this respect, it is worth researching the possibilities that complex systems theory and design methodology offer to address the real transformation that the U.S. Armed Forces, and many other Western militaries, truly require.

The Armed Forces: A Complex Adaptive System

This monograph will explore the potential contribution of complex systems theory and design methodology to address the necessity of continually transforming the military. Thus, the categorization of the Armed Forces as a complex adaptive system is instrumental for this research. If a *system* is defined as a set of interrelated elements that collectively form a whole,

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[8] "Transformation is more than modernization. Modernization is in the realm of *evolutionary* change and it involves incremental upgrades through which an organization tries to improve its ability to do what it is already doing…. while modernization improves the ability to execute missions under existing standards, transforming military capabilities redefines the standards themselves." Ibid., 8.

[9] "*Reengineering* is not transformation; it is organizational change that falls short of true transformation… this process considers only ways and means, emphasizing the former… Like reengineering, *downsizing* or *rightsizing* falls short of true transformation." Jack D. Kem, "Military transformation: Ends, ways and means," *Air & Space Power Journal* (Fall 2006): 88.

then the Armed Forces can be viewed as a 'system of systems' requiring integrated networking among multiple distributed systems to create a unified whole.[10]

Complex systems science provides a useful framework for understanding systems of systems such as the Armed Forces. Complex systems science had its conceptual origins in chaos theory and General System Theory (GST), but soon gained independence as a distinct interdisciplinary approach to analyzing, modeling, and intervening in a broad range of systems analysis. Conceptualization of complex systems theory requires exploring its differences with GST and chaos theory. In the 1960s, Ludvig von Bertalanffy elaborated GST as a new scientific discipline based in foundational principles applicable to systems in general: biological, social, and economic. His main contribution is the consideration of all the mutually interacting aspects that operate in a system, or systems of elements; GST was conceived as a general science of "wholeness."[11]

The conceptualization of *chaos* from a scientific standpoint is far from the idea of unstable, disordered, and confused behavior.[12] Chaos theory, attempting to address the global nature of systems, underpins its conceptual formulations in mathematical models and deterministic, non linear processes.[13] Consequently, several principles are noticeably applicable

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[10] "Armies are made up of many different systems: myriad units; organizations; command arrangements; multiple communications nets; logistic structures, and so on." David Jordan et al., *Understanding Modern Warfare* (Cambridge: Cambridge University Press, 2008), 111.

[11] "Its [GST] subject matter is formulation of principles that are valid for "systems" in general, whatever the nature of their component elements and the relations or "forces" between them. General system theory, therefore, is *a general science of "wholeness"* which up till now was considered a vague, hazy, and semimetaphysical concept." Ludvig von Bertalanffy, *General System Theory* (New York: George Braziller, 1993), 37 (eleventh printing, 1968)

[12] "*Chaos* and *instability* were not the same at all. A chaotic system could be stable if its particular brand of irregularity persisted in the face of small disturbances." James Gleick, *Chaos: Making a New Science* (New York, N.Y., U.S.A.: Penguin Books, 1988), 48.

[13] "The modern study of Chaos began with the creeping realization in the 1960s that quite simple mathematical equations could model systems even bit as violent as a waterfall." Ibid, 8. As a definition of chaos, note also: "*Chaos* is sustained and disorderly-looking long-term evolution that satisfies certain special mathematical criteria and that occurs in a deterministic nonlinear system. Chaos theory is the

to military fields, such as Information Warfare, and in many technologies associated to military systems.[14] Moreover, some tenets of chaos theory are also relevant to social systems and decision making processes, including the principle of "sensitive dependence on initial conditions" (also known as "The Butterfly Effect") and positive feedback loops.[15]

Complex systems theory elaborates some of the postulates of chaos theory and GST, but addresses an inescapable condition in most observed systems: *complexity*. Nevertheless, a proper understanding of complexity requires comprehending GST and chaos theory, as most of its underlying principles emanate from these two theoretical approaches.[16] A sense of randomness and non-deterministic processes identifies complexity, as opposed to the determinist approach that characterizes chaos. The focus of this new interdisciplinary field is on complex systems and the associated dynamics of complexity.[17] Probably, a better understanding of the definition of a complex system requires conceptually placing it at "the edge of chaos."[18] For complexity

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principles and mathematical operations underlying chaos." Garnett P. Williams, *Chaos Theory Tamed* (Washington, D.C.: Joseph Henry Press, 1997), 9.

[14] "As yet nebulously defined, the subdiscipline of military science known as Information Warfare certainly embraces a number of electronic systems subject to chaotic behavior. In many instances, chaotic dynamics contribute to the design of entirely new systems with capabilities made possible by Chaos theory." As a comprehensive work to explore the applications of chaos theory to military functions, see Glenn E. James, *Chaos Theory: The Essentials for Military Applications* (Newport, Rhode Island: Naval War College, 1996), 50.

[15] "Tiny differences in input could quickly become overwhelming differences in output – a phenomenon given the name "sensitive dependence on initial conditions." In weather, for example, this translates into what is only half-jokingly known as *the "Butterfly Effect"* – the notion that a butterfly stirring the air today in Peking can transform storm systems next month in New York." Gleick, *Chaos: Making a New Science,* 8. It refers to the fact that minor errors and uncertainties multiply in a cascade effect that can give rise to unexpected, radical consequences.

[16] "…complex systems [science] is essentially a refinement of the GST/cybernetics research agenda." Alex Ryan, *A Multidisciplinary Approach to Complex System Design* (Adelaide: University of Adelaide, 2007), 68.

[17] While *complexity* is defined as "the intricate intertwining or interconnectivity of elements within a system, and between a system and its environment", *complex system* is "a system composed of many independent parts which are coupled in a non-linear fashion." Antoine Bousquet, *The Scientific Way of Warfare: Order and Chaos on the Battlefields of Modernity* (NY: Columbia University Press, 2009), 174.

[18] "But right in between the two extremes, he says, at a kind of abstract phase transition called "the edge of chaos," you also find *complexity*: a class of behaviors in which the components of the system never quite lock into place, yet never quite dissolve into turbulence, either. These are the systems that are both

theorists, most of complex and adaptive systems find themselves at the frontier of the phenomena of chaos.[19]

Interestingly, one specific type of complex system gained relevance in complexity science, the *complex adaptive system*. This is a special case of complex systems, whose main feature is its capacity to *continually evolve and adapt* from learning and experience. Initially developed to study the behavior of living organisms, this concept soon expanded to explain other forms of social organization. Some authors even argue that the complex adaptive systems approach is "a way of looking at the world," with a great potential as a source of change in social systems, and whose principles and dynamics are of value for decision makers.[20] Consequently, the categorization of a nation's military as a complex adaptive system permits exploiting the potential of complexity theory. Complex systems theory provides the essential bedrock to elaborate a theory of the use of design methodology in the scrutiny of military transformation.

The Art of Design and *Adaptive Transformation*

In today's complex environments, a long-term transformation process of such an organization as the military that defines at the beginning a clear, detailed end state is condemned to failure. This is the essential characteristic of Traditional Systems Engineering, which has its foundations in linear systems theory, and is based on a classic construct: a preliminary design, a

stable enough to store information, and yet evanescent enough to transmit it. These are the systems that can be organized to perform complex computations, to react to the world, to be spontaneous, adaptive, and alive." M. Mitchell Waldrop, *Complexity: The Emerging Science at the Edge of Order and Chaos* (New York: Touchstone Book, 1993), 293.

[19] Referenced in Bousquet, *The Scientific Way of Warfare*, 178.

[20] "It is our argument that principles derived from working with complexity problems shed valuable light on the issues confronting policy makers and designers." Robert Axelrod, and Michael D. Cohen, *Harnessing Complexity: Organizational Implications of a Scientific Frontier* (New York: Basic Books, 2000), 22.

final design, the actual development, then testing and fielding.[21] The U.S. Army definition of its transformation towards the Future Force, with the development of the Future Combat System (FCS) to equip the BCTs towards the 2020s, represents a clear example of such a Traditional Systems Engineering approach. But such a view disregards the potential for change imposed by a multitude of unexpected events and actors, the myriad of interactions among these observed and unobserved actors, and the emergence of new patterns and self-organizing processes. At this point, complex systems science comes to the fore, as a way to cope with complexity.

A complexity science approach underpins this research. The Armed Forces, as a complex adaptive system, needs to maximize the potential of learning and positive feedback that such an approach provides, aiming at achieving the real transformation that today's military requires and which is still pending definition.

Drawing from complex systems science, we will argue that a novel approach, 'Adaptive Transformation,' is needed to enable the military to successfully face future challenges and anticipate and adapt to opponents' intentions and capabilities. The term *Adaptive Transformation* defines a process of persistent, evolutionary change that will continuously adapt the Armed Forces through maximizing learning processes derived from interactions among its constituent parts. Therefore, Adaptive Transformation builds on the aforementioned construct which depicts the relationship between MTR, RMA, and Military Transformation. Nevertheless, its conceptual visualization necessarily differs from an all-encompassing circle, as boundaries to the process need to evolve over time (see Figure 2).

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[21] In a Traditional Systems Engineering approach, "The specific desired outcome must be known *a priori*, and it must be clear and unambiguous." Douglas O. Norman, and Michael L. Kuras. *Engineering Complex Systems* (The MITRE Corporation, 2004), 9.
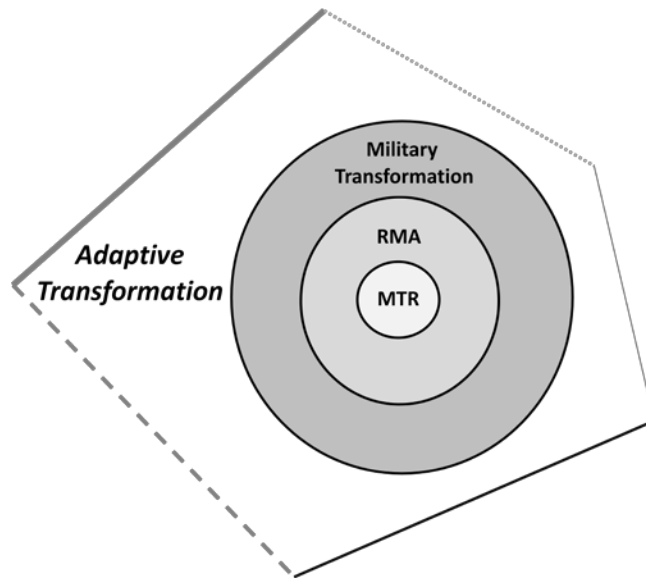
Figure 2. 'Adaptive Transformation': encompassing and expanding evolutionary change

A snapshot of the present, together with a hypothesis of the foreseeable mid- to long-term future, does not sufficiently define the transformational process for a nation's Armed Forces within a constantly evolving, complex environment. The Adaptive Transformation concept attempts to address this challenge. The Art of Design, considered as a way of "gaining systemic understanding of a situation when it is not clear what action is required and no consensus exists on the nature of the problem," has a great potential "for enhancing the commander's understanding and visualization of the situation," while providing a complementary tool for planning.[22] Consequently, the Art of Design seems an appropriate approach to tackle the underlying dynamics of a military transformation under the premises defined for Adaptive Transformation, as it has the potential to enable decision-makers at the DOD and Head of Service level to understand the complexity of today's environment and envision a way ahead towards the

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[22] Stefan J. Banach, "Educating by Design: Preparing Leaders for a Complex World," *Military Review* (March-April 2009): 97.

desired military capabilities. Design has the potential to provide the intellectual and even practical approach to elaborate a theory that defines and implements the needed Adaptive Transformation.

Unlike other disciplines that include a doctrinal body of knowledge based on systematic procedures, as for example military planning with the Military Decision Planning Process, design does not attempt such a well-defined, and rigid structure.[23] Design is the province of "critical thought, innovation, and creativity", and "is both extremely general and ubiquitous in nature."[24] This work intends to be consistent with that view, within the context of SAMS' commitment to explore the applications of design and incorporate it into officers' education.

Literature review and research methodology

There is a vast quantity of literature on the U.S. Armed Forces and Army Transformation. Official documents published by the DOD and the Department of the Army (DA) constitute indispensable primary sources.[25] Public statements of top-level military and civilian leaders before the House Armed Services Committee, as well as documents on congressional oversight through the General Accounting Office (GAO) and Congressional Research Service (CRS) Reports for Congress, represent other important research sources to analyze the scope and aims of the U.S. military transformation. In addition, there is a vast amount of third party literature on

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[23] "Most practical disciplines, such as architecture and engineering, have a body of basic knowledge and theory about what the practice is and does that can serve as a platform, a starting point, for any student or interested layman. The absence of a similar basis in *design* is one of the greatest problems it faces. Emphasizing tacit knowledge means that many design students are expected to reinvent the wheel, acquiring knowledge in an unstructured manner through learning-by-doing." John Heskett, *Design: A Very Short Introduction*. Oxford: Oxford University Press, 2005, 48.

[24] Stefan J. Banach, and Alex Ryan. "The Art of Design: A Design Methodology," *Military Review* (March-April 2009): 105.

[25] Sources to explore the DOD/ Joint official posture on the RMA and subsequently on the military transformation are: *Joint Vision 2010*, *Joint Vision 2020*, *QDR 1997*, *QDR 2001*, *QDR 2006*, and *DOD Transformation Planning Guidance*. Documents to research the Army Transformation are: General Shinseki's testimony before the Committee on Armed Services on March, 2000; *Army Transformation Campaign Plan*, April, 2001; *The Army Modernization Strategy*; *Army Transformation Roadmap*; *Army Transformation & Army Campaign Plan*; *U.S. Army White Paper: Concepts for the Objective Force*; and *Annual Army Posture Statement*. These documents permit to examine the conception and subsequent evolution of the U.S. Army Transformation.

U.S. defense transformation from defense analysts and specialized writers on military issues.[26]

These authors provide interesting reflections and, on occasion, provocative perspectives that help

analyze the significance of the military transformation, the influence of new technologies, and the

political authorities' influence on the process.

Another focus of research is the complex systems analysis and organizational theories,

which constitute the essential bedrock to subsequently explore the Art of Design.[27] Complexity

and organization theory closely relate to each other, with some notable academic works that relate

complex systems science to military organizations and processes. A third block exploring a

potential approach to transformational dynamics from a design standpoint relates to critical

thinking and design theory.[28] These references elaborate on concepts such as emergence, sense-

making, learning organization, critical thinking, and others, which are at the foundations of the

Art of Design.

Lastly, a fourth block is to focus on works related to military application of design and

systems theories. With *In Pursuit of Military Excellence,* Shimon Naveh, the father of the

Systemic Operational Design concept, advocates a systemic approach at the operational level of

war, which underpins the Art of Design. SAMS has produced a vast amount of research sources

on design; previous SAMS graduates' monographs represent valuable sources that illuminate

potential applications of design theories in the military field. Moreover, the increased attention of

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[26] Some reputed defense analysts on military transformation and defense related issues, are: Douglas A. Macgregor, Thomas Donnelly, Frederick W. Kagan, Williamson Murray, Geoffrey Parker, Max Boot, MacGregor Knox, Mark D. Mandeles, Andrew Krepinevich, Elinor Sloan, and Ralph Peters, among others.

[27] In this field, indispensable references are: James Gleick, *Chaos*; Ludwig von Bertalanffy, *General System Theory*; Garnett Williams, *Chaos Theory Tamed*; Mary Jo Hatch, *Organization Theory*; Andrew Ilachinski, *Artificial War*; Axelrod and Cohen, *Harnessing Complexity*; Mitchell Waldrop, *Complexity.*

[28] Relevant works are: Bryan Lawson, *How Designers Think*; Chris Jones, *Design Methods*; Paul and Elder, *Critical Thinking*; Karl Weick, *Sensemaking in Organizations*; Jamshid Gharajedaghi, *Systems Thinking*; Steven Johnson, *Emergence*; John Kotter, *Leading Change*; Peter Senge, *The Fifth Discipline*; Whitten, Bentley, and Dittman, *Systems Analysis and Design Methods*; Donald Schön, *Educating the Reflective Practitioner*; and John Heskett, *Design*.

design in the military field has entailed numerous articles on this topic in military publications: *Joint Force Quarterly*, *Military Review*, and *Parameters*. The work of Dr. Jack Kem, *Design: Tools of the Trade*, represents a valuable reference on design methodology and its relation with battle command. Notably, SAMS director, Colonel Banach, and Dr. Alex Ryan, have published two interesting articles in *Military Review* that describe a design methodology applicable for operational purposes. Brigadier General (Retired) Huba Wass de Czege, former director and founder of SAMS, has also published valuable articles and studies. In addition, the attempt to incorporate design into the U.S. Army doctrine has originated multiple official documents of essential analysis for this research.[29]

This work will require a *qualitative approach* to research methodology, as the nature of the sources and the sort of processes to analyze them are essentially non-quantitative. Developing a theory for the application of a design methodology to military transformation demands such a research methodology. Because the focus of a qualitative methodology is "to use gathered data to create theoretical ideas, compared with experimental research that starts with a theoretical position and accumulates data in order to test its validity", it best fits the purposes of this research.[30]

First, this work defines some key concepts that form the cornerstone of the thesis, as Art of Design, transformation, chaos, complex system, and systems design, with a view on their application for the purposes of the subsequent analysis. Second, this research will focus on the U.S. military transformation as a case study where systems theory and design methodology had a potential application in both definition and implementation processes. The U.S. case will

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[29] These documents are: FMI 5-2 Design draft (February 09); Issue Paper: Army Design Doctrine, Mar 09; Commander's Appreciation and Campaign Design (January 08); Chapter 3 "Design" in FM 5-0 draft (July 09); and The Army Capstone Concept, "Operational Adaptability" (December 2009).

[30] Martin Brett Davies, *Doing a Successful Research Project: Using Qualitative or Quantitative Methods* (New York: Palgrave MacMillan, 2007), 135.

conclude with some lessons learned and critiques, and an initial exploration of the possibilities of applied design. Then, this work will analyze those elements of design methodology which are applicable to the military transformation, and will propose a theory on the potential employment of the design methodology for defining a concept of military transformation. Finally, the research will conclude with some recommendations on how to implement the Art of Design in transformation, as an extension of the role of design methodology to other institutional aspects apart from campaigning.

Case Study: the U.S. Military Transformation.

At the turn of the century, both DA and DOD senior leaders announced their intent to undertake drastic, revolutionary changes within their departments. First in 1999, General Eric Shinseki, Army Chief of Staff, and later in 2001, Donald Rumsfeld, Secretary of Defense, adopted the term 'transformation' to refer to the process that would allow the U.S. military to prevail against the emerging threats of the 21st century. Nonetheless, this so-called "military transformation" was not properly transformation; it represented just *an extension of the RMA* as defined in the 1990s, although focused on the military applications of new technologies. In addition, the definition of a desired end state predominantly in terms of technological achievements, as it was the case of the Future Combat System for the U.S. Army, did not account for an inescapable reality: the uncertainty and complexity of current and future operational environment.

Just another chapter of the RMA: the technological focus

In the first half of the 1990s Andrew Marshall, head of the Office of Net Assessment, elaborated the premises of the RMA that the U.S. military had to implement in order to adapt itself to the new security scenario. The Joint Vision 2010, published in 1996, represented the

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official acceptance of the RMA doctrine, as stated in the 1997 Quadrennial Defense Review

(QDR).[31] Four operational concepts (dominant maneuver, precision engagement, full dimensional

protection, and focused logistics) would permit achieving Full Spectrum Dominance as the key

characteristic of the U.S. armed Forces for the 21st century, enabled by the new information age

technologies.[32]

Nevertheless, another term soon began to overshadow the RMA: 'transformation.' The

QDR 1997 included in Section VII "Transforming U.S. Forces for the Future" a guide to achieve

the needed transformation of the U.S military, largely based on information and command and

control capabilities. Actually, this document used the terms 'RMA' and 'transformation' in a

confusing manner: initially, both terms are presented as synonyms, but later RMA is referred to

as the enabler of transformation.[33] The conceptual bewilderment had just begun.

In late 1990s, *transformation* substituted for the *RMA* as the catalyst for military change

in most U.S. official documents and defense analysts' works; the newly coined term

'transformation' subsumed the RMA postulates (see Figure 1). In October 1999, General Shinseki

announced his commitment to undertake a "comprehensive transformation of the Army," while

conceding a key role to technology investments as the driving force of the process.[34] The Chief of

Staff of the Army presented his transformational view to Congress in March 2000, under the title

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[31] "The goals set forth in Joint Vision 2010 are the foundation for a broader effort to exploit the Revolution in Military Affairs." Department of Defense (DOD), *Quadrennial Defense Review Report* (1997), Section VII.

[32] Chairman of the Joint Chiefs of Staff (CJCS), *Joint Vision 2010* (1996), 1.

[33] "The ongoing *transformation* of our military capabilities - the so-called *Revolution in Military Affairs* - centers on developing the improved information and command and control capabilities needed to significantly enhance joint operations." Department of Defense (DOD), *Quadrennial Defense Review Report* (1997), Section VII. Nevertheless, later this Section elaborates on how to exploit the RMA to achieve the transformation.

[34] "We will jumpstart the process by investing in today's off-the-shelf technology to stimulate the development of doctrine, organizational design, and leader training even as we begin a search for new technologies for the objective force. Doing so will extend our technological overmatch." Eric K. Shinseki, *The Army Vision: Soldiers on Point for the Nation* (October 1999).

"On Army Transformation." The Objective Force, the desired end state of "the critical path of Transformation," would combine protection and deployability through a massive technological research and development effort.[35] Although other areas of the DOTMLPF domain also experienced important changes, the *materiel* domain soon became the priority of the Army transformational effort, with the development of the Interim Brigade Combat Team, later Stryker Brigade Combat Team, and a vast array of brand new associated technologies.

At the DOD level, newly-appointed Defense Secretary Donald Rumsfeld launched his transformational agenda in 2001. While running for office, George W. Bush had announced publicly his intent to transform the U.S. military; the appointment of Rumsfeld for this specific endeavor was due to his experience as former Secretary of Defense, and his credentials as an experienced, efficient manager in the corporate world.[36] Nevertheless, two major influences had already biased his transformational approach even before taking office. Interestingly, one was Andrew Marshall, Rumsfeld's personal acquaintance, who had familiarized him with the RMA postulates. The second major influence was the warfare theorist Harlan K. Ullman, whose work *Shock and Awe: Achieving Rapid Dominance* (1996) was inspirational for Rumsfeld's way of conceiving warfare, as he demonstrated in his preferred strategy for conducting Operation Enduring Freedom against the Taliban regime in Afghanistan, in 2001. There are grounds for considering this campaign as "*Shock and Awe* off-the-shelf, as well as the final validity test of the RMA's postulates:" minimum footprint on the ground, with maximum employment of small

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[35] "These and other questions guide *a major science and technology (S&T) effort* to develop technologies that will give the Objective Force its desired characteristics—responsiveness, agility, versatility, deployability, lethality, survivability, and sustainability. The President's Budget calls for $1.3 billion in FY2001 for this endeavor. $500 million of that will focus on developing *future combat systems* technologies." Eric K. Shinseki, *On the Army Transformation*. Presented to the Committee on Armed Services, U.S. Senate, Second Session, 106th Congress (March 2000), 8.

[36] "To the outside world, it seemed that Rumsfeld, the tough, efficient manager, the no-nonsense CEO, was just the man to use modern business methods that would force the American military machine into the twenty-first century. Rumsfeld himself was fond of talking about "changing the culture" of the Pentagon and the need to implement new tactics, techniques and procedures." Andrew Cockburn, *Rumsfeld: his Rise, Fall, and Catastrophic Legacy* (New York: Scribner, 2007), 109.

Special Operation Forces, precision air strikes, and a robust supportive information campaign.[37] The implementation of this operational approach also demanded big investments in new weapons, equipment, and information technologies.

Shortly after taking office, Rumsfeld established the Office of Force Transformation as the agency responsible of coordinating and driving DOD transformation. He appointed retired Vice Admiral Arthur K. Cebrowski to lead this effort, who was well-known as a theoretician and proponent of network-centric warfare (NCW).[38] A central premise of this operational concept is the integration of sensors, platforms and decision-makers through extensive use of modern information technologies.[39] Certainly, NCW also considered the important changes in organizations and doctrine that the integration of new information technologies would require in the future.[40] But the implementation of information superiority on the battlefield through networking the different operational elements with robust information systems was the prevalent premise. Again, the technological stance seemed to prevail in the DOD transformational approach.

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[37] Luis Cepeda, *U.S. Army Transformation Towards a Brigade-Centric Model: Lessons Learned for the Spanish Army* (Master of Military Arts and Science. Fort Leavenworth, KS: Command and General Staff College, 2009), 52.

[38] Mark D. Mandeles, *Military Transformation Past and Present: Historic Lessons for the 21st Century* (Westport, Conn.: Praeger Security International, 2007), 3.

[39] "We define NCW as an information superiority-enabled concept of operations that generates increased combat power by networking sensors, decision makers, and shooters to achieve shared awareness, increased speed of command, higher tempo of operations, greater lethality, increased survivability, and a degree of self-synchronization. In essence, NCW translates information superiority into combat power by effectively linking knowledgeable entities in the battlespace." David S. Alberts, John Garstka, and Frederick P. Stein. *Network Centric Warfare: Developing and Leveraging Information Superiority.* CCRP publication series, 2nd edition (Washington, D.C.: CCRP, 2000), 2.

[40] "To reach its full potential, NCW must be deeply rooted in operational art. As such, we cannot simply apply new technologies to the current platforms, organizations, and doctrine of warfare… as we continue to apply emerging information technologies, we should not be surprised by the need to explore new warfighting concepts that employ new organizations or new processes." Ibid., 3.

The publication of the QDR 2001 officially endorsed the DOD transformation, which placed 'transformation' at the heart of the new defense strategic approach.[41] Noticeably, the QDR 2001 refers to the RMA within a paragraph dedicated to "Key Military-Technical Trends" in terms of the contribution of military technologies to the changing operational environment.[42] Furthermore, the QDR identified "six critical operational goals" that would "provide the focus for DOD's transformation efforts", most of them focused on materiel, technological solutions rather than organizational and doctrinal change.[43] We can conclude that, implicitly, the QDR 2001 relegated the military transformation to the technological sphere, depriving this concept of its original comprehensive approach that included doctrinal and organizational aspects.

An examination of these approaches permits inferring that both the Army and the DOD had conceived of military transformation focused on the materiel, technological domain over other doctrinal, organizational considerations. Consequently, there are no grounds to define it as a '*military revolution*', the term that we could more specifically equate to 'military transformation'; since the emphasis on technology does not qualify such a revolution.[44] The situation up to now is far from those revolutionary changes that military organizations experienced at previous times in history. One genuinely revolutionary example is the French revolution and the *levée en masse*,

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[41] "The defense strategy calls for the transformation of the U.S. military and Defense establishment over time. *Transformation* is at the heart of this new strategic approach.… Without transformation, the U.S. military will not be prepared to meet emerging challenges." Department of Defense (DOD), *Quadrennial Defense Review Report* (2001), 16.

[42] See subparagraph "Rapid advancement of military technologies" in reference to the contribution of the RMA to transform the U.S. military. QDR 2001, 6.

[43] These operational goals are: *protecting critical bases of operations* and defeating CBRNE weapons and their means of delivery; *assuring information systems* in the face of attack and conducting effective information operations; *projecting and sustaining* U.S. forces in distant anti-access or area-denial environments; denying enemies sanctuary by providing *persistent surveillance, tracking, and rapid engagement* with high-volume *precision strike*; enhancing the capability and survivability of *space systems* and supporting infrastructure; and *leveraging information technology*. QDR 2001, 30

[44] "*Military revolutions* have normally resulted from massive social and political changes that have restructured societies and states, and fundamentally altered the manner in which military organizations prepared for and conducted war… *changes in society and politics – not in technology alone –* are the most revolutionary forces of all." MacGregor Knox, and Williamson Murray, *The Dynamics of Military Revolution 1300- 2050* (New York: Cambridge University Press, 2001), 176.

which implied the adoption of completely new ways of conceiving warfare in conjunction with the implementation of radically new social and political realities. These circumstances are not occurring either in the U.S. military or in American society today.

'Military transformation' became the new creed to label these processes of change. Shortly thereafter, most Western defense establishments had also espoused the concept in order to address the necessary reforms to face new challenges for the next decades, although adapting them to their specific geopolitical situation and budgetary realities. But despite this apparent agreement in labeling these processes as *transformational*, the concept itself has as many different meanings as organizations using it. Public appearances of political and military leaders often refer to it in vague, undefined terms that lead to confusion. Notably, the NATO Secretary General referred to military transformation as a synonym of "acquiring modern capabilities."[45] Some authors even concede two different interpretations to transformation; one vision identifies it with the RMA aspects, mainly concerned with unmanned aerial vehicles, long range precision strikes, advanced information systems, and lighter, modular ground forces. But the other vision advocates the necessity of *transforming transformation* through enhancing capabilities for counterinsurgency and stabilization, reconstruction missions as the authentic transformational dimension required to face today's operational requirements.[46] Other analysts argue that there is little innovation in some core transformational principles, which adds more debate as to the real meaning of the term.[47] Accordingly, this lack of consensus and conceptual rigor in the use of the

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[45] "*Military transformation – acquiring modern capabilities – does not come for free. It has to be funded. And that is why I welcome Canada's recent decision to increase significantly defense spending and investment in the Canadian armed forces." Jaap De Hoop Scheffer, *Speech by NATO Secretary General, Jaap de Hoop Scheffer, at the Canadian War Museum.* June 15, 2006.

[46] Sloan, *Military Transformation and Modern Warfare*, 129.

[47] "Many of the precepts of 'post-modern' land warfare are hardly new: jointery, combined arms. Maneuver, dispersal, surprise, flexibility, disruption, simultaneity and tempo, for example, are core themes in the evolution of modern warfare. The 1991 Gulf War and the 2003 Iraq War were both very conventional victories in this sense. In the end, even the latter war was a twentieth century fight, albeit with

term 'transformation' not only creates confusion but also endangers effective transformational policies.

Nevertheless, this confusion did not just affect transformation; it had a precedent in the failed agreement on the significance of the RMA concept.[48] Although the Office of Net Assessment had publicly stated its scope beyond the technological aspects to include organizational and doctrinal issues, many reputed defense analysts do identify RMA solely with the use of new technologies and equipment for military purposes.[49] Others highlight the attractiveness of RMA among political decision-makers, as it provides a seemingly appealing, inexpensive way of winning wars.[50] There are also fierce critics to the RMA postulates, considering it as nothing more than a substitution of the soldier by the satellite on the battlefield, while accusing it of ignoring the eternal, unchangeable, uncertain, and violent nature of war.[51]

Consequently, the declared intent to implement a transformation for the U.S. Army, and comprehensively for the DOD, conceptually and in reality has fallen short of expectations. Although some transformational measures were implemented in all the aspects of the DOTMLPF domain, the technological and materiel aspects gained precedence over the rest. Instead of real

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improved jointery, tempo, precision firepower and intelligence." David Jordan et al., *Understanding Modern Warfare*, 17.

[48] Sloan, *Military Transformation and Modern Warfare*, 4.

[49] "The RMA consists of a synergy between three elements: first, state-of-the-art intelligence, surveillance, and reconnaissance; second, advanced command, control, communication, computer, and intelligence assets; and, third, precision-guided munitions." Geoffrey Parker, *The Cambridge History of Warfare*. New York: Cambridge University Press, 2005, 419. Note also: "The basis of this thinking [RMA] was founded on the perception that technology was providing new means for the conduct of war: improved precision; improved means for delivering firepower; and, crucially, new systems for collecting and processing information." David Jordan et al., *Understanding Modern Warfare,* 110.

[50] "But the RMA bug had infected the armed forces, the Clinton administration, and Congress. Its attractiveness ranged from the promise of *quick, decisive, and bloodless* (from the U.S. perspective) *wars* to the prospect of even lower defense budgets buying revolutionary, dominant military power." Frederick W. Kagan, *Finding the Target: The transformation of American military policy.* New York: Encounter Books, 2006, 219.

[51] "The RMA claimed to substitute technology for flesh and blood on the battlefield… The claims were not merely lies. They were among the most expensive lies in history." Ralph Peters, *New Glory: Expanding America's Global Supremacy*. New York: Penguin Group, Sentinel, 2005, 30.

military transformation, it represented *just an extension of the RMA postulates*, with investments in new technologies for the Future Combat System as the main transformational effort. Far beyond some organizational and doctrinal changes, as for example the adoption of the modular concept and "full spectrum operations" as the operational concept for the Army, the U.S. military needs to implement a new approach to defining the terms of this all-encompassing, comprehensive, and radical change that implies the term transformation. The terms and scope of the authentic transformation that the U.S. military requires to face the challenging environment in decades to come is still pending definition.

Transformation as a continuous, adaptive process

We conceptualize *transformation* for a certain organization as a process of *radical, comprehensive change* in all aspects affecting its structure, functioning, and equipment, towards achieving a *desired end state* in the long term. Thus, the need of defining the 'end' in a transformational process is indisputable, as an integral piece to construct a transformational model. Transformation, therefore, is a path towards a desired end state. It drives and provides coherence to all the measures to define and implement change in the different domains affecting the organization. In 1999, the U.S. Army defined this end state in terms of an Objective Force, later named Future Force, that would became operational at the end of the 2010s, a twenty-year timeframe. The Future Combat System (FCS), the most expensive investment program that the U.S. Army ever undertook, became the backbone of this Future Force, as it would equip the Brigade Combat Teams (BCTs) in the long term.

But as has already been demonstrated, the realities of today's environment have rendered this approach infeasible. Unexpected, dramatic events as the 9/11 terrorist attacks, and the Bush administration's subsequent decision to engage in a global war on terror have modified the

Army's transformational agenda radically.[52] If a single word has to define our capacity to evaluate the current environment, it is *uncertainty*. The opponent is prone to use unpredictable procedures, structures, and even targets, as we have unfortunately learned from jihadist terrorism recently. Nevertheless, this uncertainty does not solely refer to the adversary's activities. The U.S. Army's own transformational processes and procurement programs are subject to a high level of uncertainty that has the potential to drastically modify initial intents, as shown by the FCS program.[53] The longer the time frame of a process, the greater the likelihood that unexpected modifications will occur. This is certainly the case with complex investments programs. Entrusting the transformation agenda overwhelmingly to the materiel and technological domain increases the potential to derail the whole transformational process.[54] Consequently, not only an adversary's actions, but also one's own political and budgetary decisions can substantially modify the desired end state as defined years before. The cancellation of the FCS program, recently decided by Secretary of Defense Gates, is a clear evidence of this reality.[55]

Nevertheless, we do not mean that military transformation, as defined above, has become an unattainable, hollow concept. The quest for changing our military organizations to adapt to

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[52] "The experience of land warfare in the post-9/11 period has frustrated nearly every aspect of the transformational approach…. Our strategic situational awareness has become, as former defense secretary Donald Rumsfeld might have put it, an "unknown unknown." If there is a single quality that U.S. land forces must recover, it is the ability to operate-and to win-in an *uncertain an opaque environment,* accepting that perfect clarity is unattainable." Thomas Donnelly, and Frederick W. Kagan, *Ground Truth: The Future of U.S. Land Power* (Washington, DC: American Enterprise Institute Press, 2008), 93.

[53] "The FCS program exists in a *dynamic national security environment* which *could significantly influence the program's outcome*… Some question if FCS, envisioned and designed prior to September 11, 2001 to combat conventional land forces, is relevant in this "Long War" where counterinsurgency and stabilization operations feature prominently." Andrew Feickert, *The Army's Future Combat System (FCS): Background and Issues for Congress,* CRS Report for Congress (updated May 12, 2008), Summary.

[54] "The blind faith that paper acquisition and budgeting plans and elaborately expressed goals for new military capabilities translate directly into improved operational capability transcends political party and particular administrations, imperiling the goal of planned and directed military transformation." Mandeles, *Military Transformation Past and Present,* 6.

[55] "As a result of strategic decisions in formulating the Defense portion of the Fiscal Year (FY) 2010 President's Budget, I hereby cancel the FCS BCT acquisition program." Ashton B. Carter, Under Secretary of Defense, *Memorandum for Secretary of the Army: Future Combat Systems (FCS) Brigade Combat Team (BCT) Acquisition Decision Memorandum,* DOD, June 23, 2009.

new challenges and missions is a must, and military transformation is the way to conceive and implement such change. But DOD and service-level planners have to implement a new approach to the definition of its terms to successfully tackle uncertainties and today's ever-changing environment. This approach, while maintaining the concept of military transformation as defined before, should incorporate two premises. First, military transformation needs conceptualization as a *continuously evolving, self-adapting process*. Second, the terms to define its *desired end state* need revision. The incorporation of these principles will permit further exploration of military transformation under the lens of complexity and systems theory.

Other conceptual considerations notwithstanding, there is an apparent consensus on considering military transformation as a continuous process of change.[56] It requires a critical and creative intellectual approach to the problem of transformation, as well as structures and processes that facilitate this continuous change to adapt the military to the new requirements.[57] Consequently, developing the military as a *learning and adaptive organization* is the backbone to effectively implement those changes that transformation demands.

In addition, a transformation concept must not define the desired end state in absolute terms, as the experience of the U.S. Army transformation with the FCS program illustrates. This end state, the guiding principle that drives the transformational process, has to be defined as a *zone of tolerance* that is able to respond the uncertain demands for the military in a two-decade horizon. Uncertainty not only in the long-term, but also in the current environment, makes this a necessity.

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[56] "But the notion of revolutionary change indicates a definitive end-state; a point at which the change has been accomplished. Military transformation, by contrast, captures the idea of *ongoing change*… the idea of transformation as a continuing process rather than a destination or event has become a mantra in Western defense policy thinking." Sloan, *Military Transformation and Modern Warfare*, 8.

[57] "Furthermore, a transformation of operational capability may be hindered, retarded, or delayed by organizational processes and actions that reduce the ability of individuals to apply knowledge and analysis to their tasks." Mandeles, *Military Transformation Past and Present*, 6.

Elaboration of an actionable transformation concept necessarily hinges on these premises. Planners at DOD and service levels with responsibility in defining their military organizations' way ahead for the long term have an extremely hard undertaking. A myriad of variables influence this process, in an uncertain, complex environment with multiple interactions amongst a great number of actors. Based on the application of complex systems theories, and the design methodology, this work proposes the concept of 'Adaptive Transformation' to tackle the problem of defining and implementing military transformation at the turn of the century.

Adaptive Transformation: Art of Design Applied

The theory for military transformation proposed in this research hinges on some principles of complex systems theory and design methodology. Thus, this section will elaborate on those concepts deemed relevant for the purpose of defining such a theory. These concepts will then be used to define a theory on military transformation: 'Adaptive Transformation.'

Military transformation and complexity

In any given Armed Forces, recognizing the characteristics of a *system* is not a challenging endeavor whatsoever. The term 'military system' is widely accepted, which means that there is a general conceptualization of the military as a system, even composed of many subsystems: command and control, education, force structure, and the like. Nevertheless, complex adaptive systems possess some specific features that, far from being detrimental to the military, present opportunities to exploit for its benefit.[58]

Every system has two basic components: *agents*, or actors, and *relationships* among them. The agents are certainly highly relevant to the system; but the relationships between them

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[58] "The thesis of this book is that *complexity can be harnessed*. So, rather than seeking to eliminate complexity, we explore how the dynamism of a Complex Adaptive System can be used for productive ends. Therefore, we ask how organizations and strategies can be designed to take advantage of the opportunities provided by complexity." Axelrod and Cohen, *Harnessing Complexity*, xi. This book presents a theory that leverages complexity as an advantage for the organization.

are the essential hallmark of the system. These relationships should be the focus in any analysis of a complex system.[59] From this standpoint, complex systems relate to *nonlinearity*; outputs from the system are out of proportion to the inputs due to multiple interactions.[60] Consequently, this essential feature demands a holistic approach to such systems, requiring in-depth consideration of the relationships among actors, as they provide the nonlinear connections that characterize complex systems.

Complex adaptive systems, as a special case of complex systems, conceptually display an interesting attribute: their capability to change and learn from experience.[61] Biological species subject to evolutionary change and social systems undergoing cultural evolution are examples of complex adaptive systems. The Armed Forces, as a social system composed of multiple agents interacting through myriads of relationships in a nonlinear manner, is an example of adaptive organization. Despite a widely recognized resistance to change, the military adapts and learns from experience out of necessity and in a much higher degree than other social systems, as it has to fulfill its role in a specific, highly demanding, complex environment: war.

Clausewitz's theory of war is close to the postulates of complex science, as he implicitly recognized war's inherently nonlinear nature. His concepts of interaction, friction, and chance led to unpredictability as an essential feature of nonlinearity as defined by contemporary scientists.[62]

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[59] "… the complexity arises because you have a great many of these simple components *interacting* simultaneously. The complexity is actually in the organization-the myriad possible ways that the components of the system can interact." Waldrop, *Complexity*, 86.

[60] "In a *linear dynamical system*, any external disturbance induces a change in the system that is proportional to the magnitude of the disturbance. In other words, small changes to the input result in correspondingly small changes to the output. *Nonlinear systems* are dynamical systems for which this proportionality between input and output does not necessarily hold. In nonlinear systems, therefore, arbitrarily small inputs may lead to arbitrarily large (and, in chaotic systems, exponentially large) output." Andrew Ilachinski, *Artificial War: Multiagent-Based Simulation of Combat* (River Edge, NJ: World Scientific Pub, 2004), 2.

[61] Bousquet, *The Scientific Way of Warfare*, 175.

[62] "… in a profoundly unconfused way, he [Clausewitz] understands that seeking exact analytical solutions does not fit the *nonlinear* reality of the problems posed by war, and hence that our ability to

From a systemic perspective, we can conclude that Armed Forces, as a system, derive their fundamental essence from their nonlinear, complex organization, which is a response to the complex and uncertain environment they must survive in. Consequently, complex systems theory is the preferred approach to interpret and influence all multiple relationships that define the military's systemic behavior, including the dynamics to achieve a transformed system towards a certain end state: the transformation. All these nonlinear dynamics influence the transformational process leading to the desired end state, which permits concluding the unpredictable, uncertain character of any military transformation, and the potential application of complex system theory to address this unavoidable feature.

Several notable research works have elaborated on the application of complex systems theory for military purposes, specifically for a better understanding of modern land warfare. Notably, Ilachinski identified the fundamental properties of a complex system in the main features of land combat, which led him to the conclusion that land combat is a complex adaptive system (Figure 3.)[63] Beyond operational aspects, there are initial explorations on the contribution of complex system theory to confront broader defense issues, as an extension of its applicability to face social problems.[64] This is significant since leaders and military planners should see military transformation as a process that transcends the defense sphere and encompasses many issues that require a comprehensive approach.[65] Figure 3 reflects the main properties of complex

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predict the course and outcome of any given conflict is severely limited." Alan Beyerchen, "Clausewitz, Nonlinearity and the Unpredictability of War," *International Security*, 17:3 (Winter, 1992), 61.

[63] "The central thesis of this paper [Ilachinski's] is that *land combat is a complex adaptive system*. That is to say, that land combat is essentially a nonlinear dynamical system composed of many interacting semi-autonomous and hierarchically organized agents continuously adapting to a changing environment." Andrew Ilachinski, *Land Warfare and Complexity, Part II: An Assessment of the Applicability of Nonlinear Dynamics and Complex Systems Theory to the Study of Land Warfare* (Alexandria, Virginia: Center for Naval Analyses, 1996), 3.

[64] Alex J. Ryan, *Military Applications of Complex Systems.* See Para 4.2, "Future Applications to Defence Problems."

[65] It is worth noting the conceptual difference in the U.S. Army doctrine between *"whole-of-government"* and *"comprehensive"* approaches, the latter including other agencies and organizations out of

systems and their identification in land combat. Thus, an analysis of these defining properties through the lens of military transformation is worthwhile to validate the application of complex science to it. The concepts that deserve closer scrutiny, some of them not explicitly included in the table, are: nonlinear interaction, feedback, tradeoffs, and adaptation.

Generic Property of Complex Systems	Description of Relevance to Land Combat
Nonlinear interaction	Combat forces composed of a large number of nonlinearly interacting parts; sources include feedback loops in C2 hierarchy, interpretation of (and adaptation to), enemy actions, decision making process and elements of chance
Nonreductionist	The overall "fighting ability" of a combat force is not a simple aggregate function of the fighting ability of individual combatants
Hierarchical structure	Combat forces organized in a command and control hierarchy
Decentralized control	There is no master "oracle" dictating the actions of each and every combatant
Self-organization	Local action, which often appears "chaotic" induces long-range order
Nonequilibrium order	Military conflicts, by their nature, proceed far from equilibrium
Adaptation	In order to survive, combat forces must continually adapt to a changing environment
Collectivist dynamics	There is a continual feedback between the behavior of (low-level) combatants and the (high-level) command structure

Figure 3. Land combat as a complex adaptive system

Source. Ilachinski, Andrew. Land Warfare and Complexity, Part II: An Assessment of the Applicability of Nonlinear Dynamics and Complex Systems Theory to the Study of Land Warfare. Alexandria, Virginia: Center for Naval Analyses, 1996, 3. http://cna.org/isaac/inetpub/ wwwroot/ isaac/lwpart2.pdf (accessed 02 February, 2010)

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the U.S. Government: intergovernmental and nongovernmental organizations, multinational partners, and private sector entities. See Department of the Army, *Field Manual 3-07, Stability Operations* (Oct 08), 1-4.

Nonlinear interaction is the defining feature of complex systems. Minor inputs in the system bring up major outputs or consequences; this issue relates with the sensitive dependence on initial conditions (see note 15.) Moreover, the importance of *interconnectedness* in a complex system emphasizes nonlinearity and the difficulty to predict future system's behavior.[66] In a transformational process, some apparently irrelevant issues can introduce huge modifications of consequence for the achievement of the end state as previously defined. Technical delays in developing the ground vehicle for the FCS program have been an instrumental factor in the decision of abandoning a future force based in FCS-BCT units as a whole.

The concept of *feedback* is of great relevance; it is instrumental to making the military a truly learning, adaptive organization. In essence, feedback consists of responses that the system produces and the system in turn incorporates. They are outputs that return to serve as inputs. The distinction between positive and negative feedback is significant. While *positive feedback* amplifies or accelerates the output and magnifies an event over time, *negative feedback* inhibits output, or causes an event to die away over time.[67] This concept is the essence of complex systems as it represents an internal source of complexity.[68] Of utmost importance is the identification of negative feedback, as a key factor that hinders the evolutionary changes of the system and, by extension, military transformation.[69]

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[66] "Emergent properties are less central to my analysis than is "interconnectedness" –in a system, the fates of the units and their relations with others are strongly influenced by interactions at other places and at earlier periods of time. When the interconnections are dense, it may be difficult to trace the impact of any change even after the fact, let alone predict it ahead of time, making the system complex and hard to control." Robert Jervis, *System Effects: Complexity in Political and Social Life* (Princeton, N.J.: Princeton University Press, 1997), 17.

[67] Williams, *Chaos Theory Tamed*, 12.

[68] "*Feedback* is a fundamental concept because it marks the difference between linear and nonlinear systems. Whereas outputs are always proportional to inputs in linear systems, nonlinear systems magnify some inputs (*positive feedback*) and counteract others (*negative feedback*). Because feedback creates interdependence, it is a source of complexity." Alex Ryan, *The Foundation for an Adaptive Approach: Insights from the Science of Complex Systems.*

[69] "*Negative feedback*… tends to perpetuate the status-quo. It maintains equilibrium in a system and, should a disturbance occur, works to return the system to equilibrium…. Thermostats are

Both positive and negative feedback are relevant to keep the system *alive*.[70] Nevertheless, awareness of the nature of those feedbacks produced and received throughout the military transformation process is relevant to maximize the potential of positive feedbacks for promoting the evolution of the system, while minimizing the effects of those negative feedbacks that impede such desired evolution. The Armed Forces is a *well-buffered system* that naturally tends to remain stable, so energy needs to be injected to overcome this tendency.[71]

This marks a significant difference between cybernetics and chaos theory. *Cybernetics* was the predominant outlook during the Cold War era, with a focus on closed systems that emphasized negative feedback as a way to avoid disturbances.[72] On the contrary, *chaos theory* leverages the positive feedback as a motor of change and evolution.[73] In this respect, *complexity* aligns itself with the postulates of chaos theory, as it also accounts for positive feedback as a source of change.[74] Complexity is often described as existing "at the edge of chaos," since systems which can keep themselves near the boundary of chaos are observed to cope with novelty and complexity much more effectively.[75] Nevertheless, unlike chaotic systems, complex systems

technological examples of negative feedback." Dietrich Dörner, *The Logic of Failure: Recognizing and Avoiding Error in Complex Situations* (New York: Basic Books, 1996), 74.

[70] "Were it not for *negative feedback*, there would be no stability as patterns would not last long enough to permit organized society. Without *positive feedback*, there could be no change and growth." Jervis, *System Effects: Complexity in Political and Social Life,* 125.

[71] "A system incorporating many variables regulated by negative feedback is a *well-buffered system.* It can absorb a great many disturbances without becoming unstable." Dörner, *Logic of Failure,* 75.

[72] "Cybernetics was essentially preoccupied with the first form of feedback [negative] since positive feedback's amplification of disturbances was seen primarily as a disruptive process to be avoided, countered, or appropriately tamed to serve the overall homeostatic objectives." Bousquet, *The Scientific Way of Warfare,* 165.

[73] "*Evolution is chaos with feedback*," Joseph Ford said. The universe is randomness and dissipation, yes. But randomness with direction can produce surprising complexity. And as Lorenz discovered so long ago, dissipation is an agent of order." Gleick, *Chaos: Making a New Science,* 314.

[74] "In theories of self-organization, positive feedback accounts for the emergence of complexity in systems in which outputs feed back into them as inputs, allowing for runaway processes of change." Bousquet, *The Scientific Way of Warfare,* 167.

[75] "Networks in the regime near the edge of chaos-this compromise between order and surprise-appear best able to *coordinate complex activities* and best able to *evolve* as well. It is a very attractive

try to maximize the effects of both positive and negative feedbacks, which in turn increase the complexity of the system. The edge of chaos is the 'comfort zone' for complex systems.

Bousquet explains this phenomenon as *chaoplexity*, which refers to the conceptual framework that combines the overlapping scientific theories of chaos and complexity. Chaoplexity manifested in the 1980s through "the increasing application of computers to the study of scientific problems, the rediscovery of non-linear mathematics, and an extension of the cybernetic analysis of systems to questions of self-production and self-organization."[76] Bousquet even defines the *Chaoplexic Warfare* as one of the four sequential regimes of the scientific way of warfare. Networks, information technologies, non-linearity, positive feedback, self-organization, emergence, and decentralization are the main characteristics of the Chaoplexic Warfare.[77] The correlation between land forces and the properties of complex adaptive systems (See figure 3) is clearly evident.

Complexity at the "edge of chaos" is the normal situation that the military must deal with. Indeed, the Armed Forces' recognition of this reality is far from representing a setback for the purposes of military transformation. Adaptation, which is the preferred attribute that this work proposes as the hallmark of military transformation, closely relates to the Armed Forces' status as a complex adaptive system. Cohen and Gooch's theory of military misfortune establishes three basic kinds of military failure: failure to learn, failure to anticipate, and *failure to adapt*. Whenever all these three types of failure happen together, 'catastrophic failure' occurs.[78]

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hypothesis that natural selection achieves genetic regulatory networks that lie near the edge of chaos." Stuart A. Kauffman, *At Home in the Universe: The Search for Laws of Self-Organization and Complexity* (New York: Oxford University Press, 1995), 26.

[76] Bousquet, *The Scientific Way of Warfare*, 34.

[77] Ibid., 30. The other regimes of the scientific way of warfare are: *mechanistic* warfare and the clock; *thermodynamic* warfare and the engine; and *cybernetic* warfare and the computer.

[78] Eliot A. Cohen, and John Gooch, *Military Misfortunes: The Anatomy of Failure in War* (New York: Free Press, 1990), 26.

However, of the three, Cohen and Gooch see adaptation as the most crucial.[79] Thus, adaptation is the centerpiece of the military effectiveness. It is also the essential tenet of a successful transformational process.

As mentioned before, the relationships amongst the different agents that compose the Armed Forces are the key elements that deserve attention. For Axelrod and Cohen, these relationships are the *strategies* or ways in which the *agents* interact with their surrounding and pursue their goals. At the same time, we can also identify groupings or *populations* of agents, and population of strategies also. Some critical *interaction patterns* among agents lead to identify causal relations and, more importantly, possibilities of intervention in the system. Inhibitions of some interaction patterns or increase in others, elimination of agents or strategies, introduction of new ones…all these changes are forms of *selection.* When this selection process leads to improvements in the system, according to some measures of success, we have achieved *adaptation.*[80] Military adaptive transformation is all about *selection* of those interventions in the system of all kinds: creation or suppression of units (agents), improvement or inhibitions of a certain command relationships amongst organizations (interaction patterns), and the like. Nevertheless, as an objection to the applicability of this model to military transformation, this selection should not necessarily entail *variation*; it might also account for *retention* of those aspects that do not require change.[81] Military transformation has to account for those *selective retentions* also.

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[79] "Indeed, the ability to adapt is probably most useful to any military organization and most characteristic of successful ones, for with it, it is possible to overcome both learning and predictive failures." Ibid., 94.

[80] Summary of Axelrod and Cohen's framework for complex systems based on Axelrod and Cohen, *Harnessing Complexity*, 3-11.

[81] Campbell coined the concept of "blind variation and selective retention" as a model for creativity. Donald T. Campbell, "Blind variation and selective retention in creative thought as in other knowledge processes," *Psychological Review*, 67 (1960): 380-400.

This concept leads to another essential feature when dealing with complexity that has an enormous influence for military transformation: the *tradeoffs* within the system. Some relevant tradeoffs are competition-cooperation, independence-interdependence, innovation-integration, specialization-multitasking, bottom up-top down, among others. Complex systems science approaches these tradeoffs in a multidimensional way that avoids the 'zero sum game' paradigm. So, there are spaces where these apparently opposing features are "synergetic and mutually reinforcing."[82] As an example, competition and cooperation can have both a reinforcing and a damaging effect on the organization as a whole according to the level in which they occur.[83]

In military transformation, some notable tradeoffs to consider are: counterinsurgency-focused training and equipment *versus* conventional-focused one; uniform, modular organization *versus* a diversified one;[84] a human-gathering intelligence focus *versus* a technological-gathering one; elite, first response units *versus* uniformly capable units; protection *versus* deployability, and the like.[85] We can conclude that these tradeoffs are an expression of the variations and selective

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[82] "*Tradeoffs* exist because there is no one right way to organize a system. The best way to organize depends on the context, which is in constant flux." Ryan, *The Foundation for an Adaptive Approach.*

[83] "The interplay between competition and cooperation can only be understood by using a multilevel perspective. Competition and cooperation will tend to support each other when they occur at different levels of organization, but they will generally be in conflict if they occur at the same level… cooperation at each level enables competition at the higher level of organization." Yaneer Bar-Yam, *Making Things Work: Solving Complex Problems in a Complex World* (Cambridge, MA: NECSI, Knowledge Press, 2004), 83.

[84] "The intrinsic merit of *standardization* is so deeply embedded into military culture that a synonym for military personnel is *'uniform'*. Dixon's classic work on the psychology of military incompetence identifies uniformity, the love of regularity, and regimentation as organizational sources of incompetence in the military. Standardization improves predictability, simplifies control, and can allow forces to produce large scale effects. However, this often comes at the expense of individual effectiveness, and necessarily decreases variety, which limits the potential of the force to adapt." Ryan, *Military Applications of Complex Systems*, 41.

[85] "As a profession that answers to the American public, we have an obligation to question the trade-off between survivability and rapid deployment capability in light of battlefield realities." Introduction by General Chiarelli to an interesting article discussing potential changes in the priorities to equip the Future Force, whose main conclusion is that "… the Army should change its priorities and have *survivability*, rather than *deployability*, as the key performance parameter of any future system." Jeffrey Peterson et al., "Revisiting Priorities for the Army's Future Force," *Military Review* (September-October 2009): 43. The article also discusses other relevant tradeoffs to consider when designing the Future Force.

retentions that are inherent to a transformational agenda. Tradeoff management and decisions concerning them constitute a defining characteristic in any transformational approach. Despite their ever-changing nature, adequate identification of these tradeoffs is an essential prerequisite for effectively intervening in the system; they embody the absence of an *optimal* end state in the transformational path, but the feasibility of an *acceptable* one.

In addition to the analysis of the relations amongst what Ilachinski called 'new sciences' –or complex systems and chaos theory– and land warfare, other aspects of Ilachinski's work are of interest for the purpose of this research on transformational issues. Specifically, he identified eight tiers of application of complex system theory to warfare. The second, "Policy and General Guidelines for Strategy," is of potential use to cope with military transformation. This Tier II derives from Tier I, which accounts for the use of general *metaphors* to better understand the complexity of war.[86] Consequently, Tier I is just an intellectual construct to use the concepts of complexity theory in providing a sensory conceptualization of warfare. Although mostly unconscious, the use of metaphors permeates and structures our ordinary thinking and behaving.[87]

Ilachinski's Tier II accounts for the use of complexity theory to guide the process of formulating strategies and general policies aimed at changing organizations and structures.[88] Thus, the applicability for transformational purposes seems promising. Insight on the behavior

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[86] *Tier I, "General Metaphors for complexity in War,"* refers to the use of "…sounding words and images [metaphors] that most strongly suggest a philosophical resonance between behaviors of complex systems and certain aspects of what happens on a battlefield. It is on this tier that the well-known Clauswitzian images of "fog of war," "center-or-gravity" and "friction" are supplanted by such metaphors as 'nonlinear,' 'coevolutionary' and 'emergent.' Ilachinski, *Artificial War*, 7.

[87] "… metaphor is pervasive in everyday life, not just in language but in thought and action. Our ordinary *conceptual system*, in terms of which we both think and act, is fundamentally metaphorical in nature." George Lakoff, and Mark Johnson, *Metaphors We Live By* (Chicago: University of Chicago Press, 1980), 3.

[88] "The second tier of applications takes a step beyond the basic metaphor level of Tier I by using the metaphors and basic lessons learned from complex systems theory to guide and shape how we formulate strategy and general policy…. It consists of using both the imagery of metaphors and the tools and lessons learned from complex systems theory to *enhance and/or alter organizational and command and control structures*." Ilachinski, *Artificial War*, 8.

and underlying principles of complex adaptive systems has a huge potential to deal with planning and implementing military transformation. Further, as an example of this applicability, Ilachinski referred to the need of dictating policies that encourage "a continual coevolution."[89] The reference to an 'adaptive transformation' principle as guiding policy for the military, though implicit, cannot be unnoticed.

Therefore, *adaptation* remains as the major theme of the relationship between complex system theory and military transformation; all the underlying principles of complexity drive to this conclusion. Once the military is acknowledged as a complex adaptive system, any approach to effectively tackle its transformation necessarily hinges on this attribute. Next, insight on other armies' approaches to deal with complexity can provide inspiration to define the proposed concept of 'adaptive transformation.'

The Australian Army has developed a novel approach to land force operations: *'Adaptive Campaigning.'* Through five interdependent and mutually reinforcing lines of operation, this concept encompasses the "[a]ctions taken by the Land Force as part of the military contribution to a Whole of Government approach to resolving conflicts."[90] 'Adaptive Campaigning' represents a radical change in the normal paradigm that the Army follows to tackle problems. Traditionally, the military has conducted deliberate planning to reach a solution prior to interacting with the problem; the longer the planning prior to an operation, the more chances of success. Nevertheless, this approach disregards the "complexities and adaptive nature of the environment."

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[89] "For example, consider that the essence of a (successfully evolving) complex adaptive system is to exist in a far-from-equilibrium state and to continually search for novelty and new solutions to changing problems. An important lesson learned for a complex systems theoretic approach to policy making is therefore to shift from general policies that emphasize a means to achieve stability to *policies that encourage a continual coevolution* of all sides." Ibid., 171. Thus, positive feedback has to be encouraged and negative feedback inhibited to ensure a continuous, adaptive change.

[90] Australian Army Headquarters, *Adaptive Campaigning: The Land Force Response to Complex Warfighting* (Canberra, Australia: Future Land Warfare Branch, Australian Army HQ, 2007). The five lines of operation are: Joint Land Combat, Population Support, Indigenous Capacity Building, Population Protection, and Public Information.

Consequently, there is a need for a model to "adapt appropriate resources and time to allow a solution to be properly developed in contact."[91]

The 'Adaption cycle' provides this construct (Figure 4). Through "an iterative process that combines the process of *discovery* (the problem is 'unknowable' until we prod it) and *learning*," this formulation attempts to confront the complexities of a continuously evolving, complex environment. As the land forces must be constantly and rapidly adapting to the emergent situation, war is a "continuous meeting engagement" within a "competitive learning environment."[92] With regard to this formulation, neither a start point nor a definite end state are viable options, as continuous learning leads to permanent adaptation within the operational environment.[93] The same dynamic, based on successive iterations of this cycle, is applicable to all levels of command.
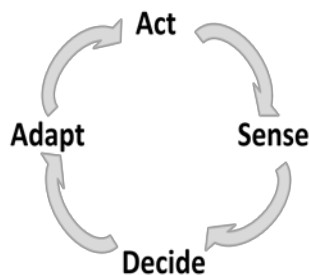
Figure 4. The *'Adaption Cycle'*

Source: Australian Army Headquarters, *Adaptive Campaigning: The Land Force Response to Complex Warfighting* (Canberra, Australia: Future Land Warfare Branch, Australian Army HQ, 2007), 7.

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[91] Ibid., 8.

[92] Ibid., 7.

[93] "There is no beginning and no end state. The idea of *'end state'* makes little sense in this context. There is a currently provisional desired state, one now believed desirable based on what is known… each combatant command is continually adapting within the ecology of their environments, as do all living beings. Success depends on learning and adapting more rapidly than rivals in the ecosystem." Huba Wass de Czege, "Systemic Operational Design: Learning and Adapting in Complex Missions," *Military Review* (January-February 2009:) 4.

The four steps in the cycle are mutually reinforcing phases of a learning-adaptation process. *Act* attempts to stimulate a response, based on our current understanding of the reality. *Sense* observes and interprets the changes incurred by our own actions, while providing essential feedback and a plan for measuring the effectiveness of such actions. *Decide* leverages on previous phase to make a decision on how and when to adapt; this step considers several levels, including problem hypothesis and strategy. Finally, *adapt* means managing the change through a new level of understanding that challenges current perceptions and implements evolution.[94]

Thus, the *'Adaption cycle'* can be defined as a *continuous, iterative, and multilayered process* that provides a framework for incorporating learning and achieving adaptation as preferred approaches to today's operational environment. This concept may be used to devise a theory on the use of design for military transformation. Ultimately, the Art of Design emanates from many of complex systems theory's guiding principles: design is the preferred approach to cope with complexity, and the military transformation clearly has the attributes of complexity.

Design beyond operations: the institutional approach

Having reviewed the main principles of complex adaptive systems relevant to the military transformation, the Art of Design deserves scrutiny. Several institutions in the U.S. Army, notably SAMS, and many scholars and thoughtful authors have extensively researched the applications of design in the operational arena in recent years. U.S. Army and Joint doctrine have incorporated operational design as a creative extension of operational art and an important

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[94] This description of the cycle is the author's interpretation accounting for the descriptions provided in *Adaptive Campaigning* document, and in Wass de Czege's, "Systemic Operational Design: Learning and Adapting in Complex Missions:" 4.

contributor to creating a campaign design.[95] Interestingly, both U.S. Army and Joint doctrine

implicitly relegates operational design to the operational level of war. Operational design seems

to be the realm of campaigns and operations.[96]

Nevertheless, the application of design for military purposes above the operational level

of war is a must to fully exploit its potential.[97] Far beyond its usefulness as a valuable

complement to existing decision-making processes, design is especially suited as a facilitator to

achieve cooperation and common understanding amongst agencies, organizations and hierarchies

inside and outside the military. The endeavor of moving the military ahead to achieve a

transformed institution, which implies multiple agents and relationships cooperating in a

synergistic manner, is an ideal field to apply the Art of Design.

In essence, the U.S. Army considers design as a methodology for a dual and interrelated

purpose: framing problems and devising possible solutions.[98] First and foremost, the U.S. Army

conceives design as an approach to cope with *complex*, ill-defined problems, which makes it a

distinct process from an analytic method for solving *complicated* problems. The distinction

between complex system and complicated system lies in the different categorization of the

problems they deal with; while the constituent elements of a complicated system are agents and

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[95] "While operational art is the manifestation of informed vision and creativity, *operational design* is the practical extension of the creative process." Joint Chiefs of Staff, *Joint Publication 3-0, Joint Operations* (2008), IV-3. See also Chapter 6, "Elements of Operational Design," in Department of the Army, *Field Manual 3-0, Operations* (Washington, DC: HQ Government Printing Office, 2008). In addition, see Chapter 3, "Developing a Campaign Design," in U.S. Army Training and Doctrine Command, *TRADOC Pamphlet 525-5-500. Commander's Appreciation and Campaign Design* (Version 1.0, 2008).

[96] "*Operational design* is a *bridge* between the strategic end state and the execution of tactical tasks." Department of the Army, *Field Manual 3-0, Operations* (Washington, DC: HQ Government Printing Office, 2008), 6-1. "Operational art is applied during *operational design*–the conception and construction of the framework that underpins a campaign or joint operation plan and its subsequent execution." Joint Chiefs of Staff, *Joint Publication 3-0, Joint Operations* (2008), IV-3.

[97] "From an institutional domain perspective, *limiting design to operational affairs* does not fully exploit its potential as a driver for cultural change, learning, and adaptation." Christof Schaefer, "Design: Extending Military Relevance," *Military Review* (September-October 2009): 30.

[98] "Design is a *methodology* for applying critical and creative thinking to understand, visualize, and describe *complex problems* and develop *approaches* to solve them." *Field Manual 5-0* (final approved draft), 2010, 3-1.

relationships separable from their environment, a complex system is composed of agents and relationships closely intertwined with the environment.[99] A great number of the problems a military commander must tackle fall under the latter category, derived from the Armed Forces' inherent nature as a social system. Furthermore, they are *'wicked problems,'* problems of social policy that traditional scientific approaches are unable to confront, but that military planners have to address based on judgment to reach an adequate solution, not an optimal, definite one.[100]

U.S. Army doctrine identifies *ill-structured problems* as 'wicked problems', owing to some defining characteristics that make them different from other well-structured or medium-structured problems. These characteristics include difficulties in agreeing on problem structure or a starting hypothesis and desired end state; success requires learning to perfect techniques, adjust solutions, and refine problem framing; and refining problem structure to find the best solution requires adaptive iteration.[101] Without any doubt, the problems that planners of military transformation have to tackle are 'wicked, ill-structured problems'.

Interestingly, Rittel and Webber came up with a characterization of 'wicked problems' which is highly relevant for the purposes of defining the end state in the military transformation. The *social nature* of these problems, as opposed to the 'tamed problems' that traditional engineering processes cope with, is the hallmark of today's military problems. Most of the characteristics of these 'wicked problems' are derived from the impossibility of defining neither

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[99] "Where merely *complicated systems* require mostly deduction and analysis (formal logic of breaking into parts), *complexity* requires inductive and abductive reasoning for diagnostics and synthesis (the informal logic of making new wholes of parts)." Wass de Czege, "Systemic Operational Design: Learning and Adapting in Complex Missions:" 3.

[100] "As distinguished from problems in the natural sciences, which are definable and separable and may have solutions that are findable, the problems of governmental planning—and especially those of social or policy planning—are ill-defined; and they rely upon elusive political judgment for resolution. (Not "solution." *Social problems are never solved*. At best they are only re-solved—over and over again.)" Horst W. J. Rittel, and Melvin M. Webber, "Dilemmas in a General Theory of Planning," *Policy Sciences* 4 (1973), 160.

[101] U.S. Army Training and Doctrine Command, *TRADOC Pamphlet 525-5-500 Commander's Appreciation and Campaign Design*. Version 1.0 (January 2008), 9.

their nature nor their solution in unequivocal terms.[102] Consequently, it is of utmost importance that military transformation planners be adept at identifying problems that fall under the category of 'tamed problems' and suited for a *traditional engineering approach*, and those which are 'wicked problems' and suited for an *Art of Design approach*.

The second major feature of the U.S. Army conceptualization of the Art of Design is its usefulness to contrive possible *solutions* for these problems. Consequently, design is not an end in itself; design is just the tool that helps reach a non-optimal, although acceptable solution to the problem as formulated during the design process. From this standpoint, an *operable* Art of Design necessarily requires a certain *methodology* that provides some structure and common language to the design team and leverages the different tools that design provides to military planners; ultimately, this is the U.S. Army's conceptualization of design.[103] Its creative stance by no means precludes the necessity of a methodology that guides the dynamics and discourse within the design team. In fact, education on this methodology is an unavoidable first step to allow later adaptations of the model to the particularities of a certain problem or situation.[104] Design is not a lineal, rigid approach to solve problems whatsoever, but requires a commonality in concepts and processes that provides a common ground for military designers to perform their job.

The object of this research is not to develop a design methodology, for other works have already captured the Art of Design at the level of methodology, as well as at the level of design

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[102] Some characteristics of 'wicked problems' have to do with their definition ("There is no definitive formulation of a wicked problem") and with their possible solution ("Wicked problems have no stopping rule," "Solutions to wicked problems are not true-or-false, but good-or-bad," "There is no immediate and no ultimate test of a solution to a wicked problem," "Every solution to a wicked problem is a 'one-shot operation'; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.") Rittel and Webber, "Dilemmas in a General Theory of Planning," page 161onward.

[103] As noted before, for the recently published FM 5-0, "Design is a *methodology* for applying critical and creative thinking…"

[104] "Controlling and varying the design process is one of the most important skills a designer must develop." Bryan Lawson, *How Designers Think* (Amsterdam: Elsevier/ Architectural Press, 2005), 124.

tactics and methods.[105] Moreover, the recent publication of FM 5-0 has elevated a design methodology to the category of doctrine.[106] In addition, in recent years several studies and drafts of doctrinal documents, although not officially approved, have outlined a methodological approach to design.[107] Nevertheless, this work proposes an initial approach to a design methodology that capitalizes on existing studies and adapts them to the purpose of addressing the problem that military planners have to deal with when planning and implementing military transformation.

The essence of the U.S. Army's methodological approach to design hinges on the concept of *cognitive space*. Conceived as a useful tool to organize information and intellectual processes in broader terms than a frame does, the cognitive space encompasses both actors –the social element– and relational dynamics amongst them –the cognitive element.[108] The cognitive space represents a potential trigger for organizing processes, as it serves practical purposes. The cognitive space confines thinking processes, but does not strictly bound intellectual activities.[109] Thus, we can define cognitive space as a scalable, intellectual tool to help organize thinking

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[105] See for example Alexander Bullock, *Engineering Design Theory: Applying the Success of the Modern World to Campaign Creation* (Fort Leavenworth, KS: School of Advanced Military Studies, 2009).

[106] The recently final approved draft of *FM 5-0, The Operations Process*, in Chapter 3, "Design", includes a design methodology.

[107] See Jack D. Kem, *Design: Tools of the Trade* (Fort Leavenworth, Kansas: U.S. Army Command and General Staff College, 2009). *Military Review* has published several articles on design methodology recently, which are referenced above. SAMS' students have also conducted notable research on this topic. In addition, some doctrinal drafts which are valuable for this purpose are FMI 5-2 "Design," and "Issue Paper: Army Design Doctrine."

[108] For Peverelli, *cognitive space* is "[A]n association of any number of actors bound by a certain shared cognitive element." Peverelli, Peter J. *Creating Corporate Space: In Search of Chinese Corporate Identity,* Research Memoranda, 2004 (Amsterdam: Vrije Universiteit, 2004), 11.

[109] "… the term *space* refers to something that confines, but is broader than the notion of configuration…. Moreover, spaces differ in their degree of specificity. Larger, more diffuse, spaces can comprise smaller, more specific, spaces, which will inherit the traits of the larger, space, while adding some specific traits of their own," Ibid., 11.

within a creative, intellectual process. From this standpoint, it serves to frame the design methodology.

The U.S. Army's design methodology recognizes three *cognitive spaces* - the environmental, the problem, and the solution spaces. They answer three basic questions designers have to address to successfully create a *design concept*:

What is the context in which design will be applied?

What problem is the design intended to solve?

What broad, general approach will solve the problem?

In turn, each cognitive space focuses on a distinct mode of thinking: divergent, transformational, and convergent, which correspond, respectively, with the environmental space, the problem space, and the solution space.[110] This is the foundation of the design methodology proposed by the U.S. Army (See Figure 5.)
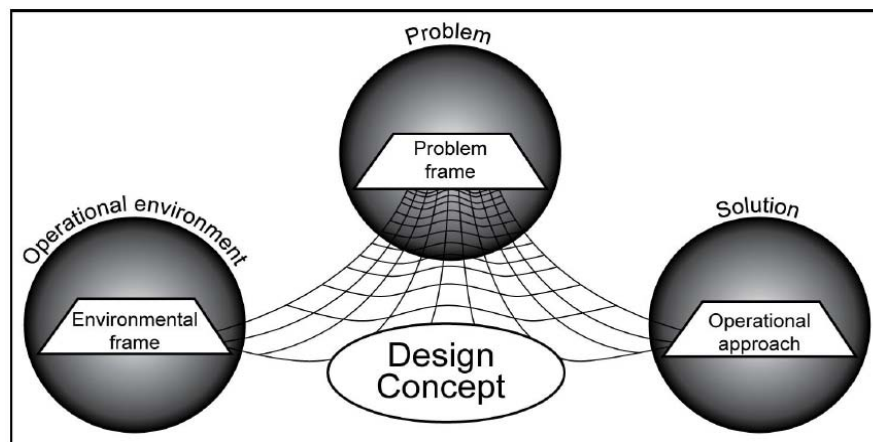

Figure 5. The design methodology

Source: Department of the Army, *Field Manual 5-0, The Operations Process* (Final Approved Draft). Washington, DC: HQ Government Printing Office, 2010, 3-7.

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[110] Department of the Army, *Field Manual Interim 5-2 "Design" (Draft)*, 20 February 2009, 17.

Jones developed these three modes of thinking –divergent, transformational, and convergent– as *a three-stage process of design* that, although not necessarily sequential, are separated to enable effective application of a design methodology.[111] In turn, the three cognitive spaces do not refer to a timely, linear process, but a multidimensional construct to capture ideas and organize concepts throughout the design process.[112] Both concepts are congruent and complementary for the purpose of defining a design methodology.

The *environmental space* is concerned with making sense of the context; divergent thinking and deconstruction are the predominant themes, and analysis the preferred intellectual approach. The *problem space* is where the transformational thinking occurs; the divergent ideas demand a creative activity to define the nature of the problem and devise potential outcomes. This is probably the most challenging space. Finally, the *solution space* leverages convergent thinking and synthesis to develop a solution in the form of a design concept. Ultimately, design is inherently a *utilitarian* process that must satisfy some need within the social system.[113] A *design concept* is the desired final result; it can adopt multiple forms, according to the nature of the problem to deal with: operational approach, planning guidance, policy directive, and strategic guidance, amongst others.

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[111] "Confusing and unhelpful as it may be to a professional designer to think on these three things as separated, there is little doubt that their separation is prerequisite for whatever changes of methodology are necessary at each stage before they can be reintegrated to form a process that works well at the system level." J. Christopher Jones, *Design Methods,* 2nd ed (New York: Van Nostrand Reinhold, 1992), 64.

[112] A valid conceptualization of cognitive space is: "*Cognitive space* starts with the individual, and *how he or she interacts with and makes sense of the world*. Each person is unique, and will take in, process, evaluate and learn from external stimuli and exchanges in their own unique way. At the heart of cognitive space is the understanding and appreciation of diversity." http://www.learning-space.org.uk/Cognitive-space (accessed February 17, 2010)

[113] "Design cannot be practiced in a *social vacuum*. Indeed it is the very existence of the other players such as clients, users, and legislators which makes design so challenging." Lawson, *How Designers Think*, 237.

For the purpose of military transformation, the design concept would be a *transformation guideline* which serves to develop specific actions, both physical and intellectual, to address the *problem* as defined during the design process. Nevertheless, this utilitarian stance results in an *operable* transformation guideline that has to account for an unavoidable reality: the uncertainty and unpredictability of an ever-changing environment. This is the major dilemma that military planners in a transformational process need to address.

Recently, the U.S. Army has recognized 'Operational Adaptability' as its new conceptual focus to address the uncertainty and complexity that prevail today.[114] This document may be considered as a reaction against the previous transformational approach of the U.S. Army that aimed at a Future Force in a fifteen to twenty-year horizon, but that realities rendered infeasible. Although implicit, the reference to the FCS seems evident.[115] As a force equipped with the FCS represented the hallmark of the force transformation, the afore-mentioned political decision (See note 3) to abandon this highly expensive, technologically risky project has derailed most of the transformational effort.[116]

Some authors are exploring other ways to develop required capabilities for defense as an alternative to the traditional system engineering methodology that prevails today. Complex system theory would provide the foundation for a self-organizing capability development that

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[114] "This concept [*Operational Adaptability*] acknowledges that the nature of armed conflict remains firmly in the realm of *uncertainty* because of war's political nature, its human dimension, its complexity, and continuous interactions with determined, adaptive enemies who will employ countermeasures to U.S. surveillance, technical intelligence, and precision strike capabilities." U.S. Army Training and Doctrine Command, *TRADOC Pamphlet 525-3-0. The Army Capstone Concept. Operational Adaptability: Operating under Conditions of Uncertainty and Complexity in an Era of Persistent Conflict, 2016- 2028* (December 2009), 6.

[115] "… the Army must take an evolutionary approach to capability development rather than pursue *"leap ahead" capabilities* that may prove irrelevant by the time they are mature." Ibid, 6.

[116] "It [the Army] has begun other Current to Future Force transformation initiatives that include actions to complete Stryker brigade combat team fielding and *focused transformation of operational forces toward an FCS-equipped force.*" Department of the Army, *U.S. Army Transformation Roadmap* (Army Transformation Office, 2004), viii.

enables a more responsive and flexible method to satisfy new requirements.[117] Interestingly, the recently published QDR 2010 echoes this approach as it addresses the need for institutionalizing a "Rapid Acquisition Capability" based on "agile, adaptive and innovative structures capable of quickly identifying emerging gaps and adjusting program and budgetary priorities to rapidly field capabilities that will mitigate those gaps."[118]

It is worth noting the difference between ambiguity and uncertainty, as these terms are often misleading. They are complementary but distinct concepts. In essence, *ambiguity* refers to "lack of clarity or consistency," while *uncertainty* relates to "lack of understanding."[119] Thus, addressing uncertainty through enabling a better understanding does not necessarily reduce ambiguity. Technological and procedural approaches to cope with uncertainty by improving *understanding* do not correlate with improvements in *clarity* or *consistency*. Moreover, this fact relates to the increased critiques to the NCW concept with regard to its real capabilities to even create a better understanding that might reduce uncertainty. Some authors posit that the NCW thesis is a manifestation of a "discredited epistemological position known as *naïve inductivism*" that needs to be countered with "an alternative outlook called *critical rationalism*" based on human creativity rather than on data and massive amounts of information.[120]

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[117] Alex J. Ryan, and Douglas O. Norman, *Agile and Flexible Capability Development,* Land Warfare Conference 2006 (Brisbane, Australia: The MITRE Corporation, 2006).

[118] "To prepare the Department for the complex threats that will surely emerge in the future, we need to make our "deliberate" processes more agile and capable of responding to urgent needs. During periods of conflict, in the traditional risk areas of cost, schedule, and performance, "schedule" often becomes the least acceptable risk." Department of Defense (DOD), *Quadrennial Defense Review Report* (2010)*, 81.

[119] "*Ambiguity* refers to a lack of clarity or consistency in reality, causality, or intentionality. Ambiguous situations are situations that cannot be coded precisely into mutually exhaustive and exclusive categories… Ambiguity is related to, but distinguishable from, uncertainty. In most theories of decision making, *uncertainty* refers to imprecision in estimates of future consequences conditional to present actions… The idea is that there is a real world that is imperfectly understood… Uncertainty is a *limitation on understanding* and intelligence." James G. March, and Chip Heath, *A Primer on Decision Making: How Decisions Happen* (New York: Free Press, 1994), 178.

[120] "*Uncertainty* is fundamental in nature, rather than just a residual insufficiency of information. *Truth* is not buried in the data, *information* does not bring about knowledge, and the best answer is not

The major *dilemma* that transformation's planners have to address relates to the terms in which they define the military transformation's desired end state. The more specific this end state is defined, the easier all subsequent transformational actions are programmed and implemented. But at the same time, this clear end state will make it more difficult to deal with the inevitable uncertainty and change that will occur in the process. Again, the Future Force's reliance on the FCS program as a well defined, explicit end state comes to mind. Hayward offers a possible solution to this dilemma with his definition of 'zone of tolerance.' This concept defines an area which represents our systemic understanding bounded by our values and desires in relation to the environment; what is tolerated goes inside, and the intolerable remains outside.[121] Thus, this 'zone of tolerance' is useful to address the dilemma of military transformation planners.

Insight on complexity and chaos theory can also shed light on this issue. The concept of 'attractor' helps explain how military transformation planners can address their dilemma. Within a dynamical, complex system the attractor is where the system tends to converge over the long term; it is relevant to understanding the system's long-term behavior.[122] The attractor lies and exerts its influence within a basin of attraction; metaphorically, the attractor brings the system over time deeper into this basin of attraction which, ultimately, provides order and stability to the system.[123] Making the system surpass the border between attractors requires energy, as the basin

normally within reach even in principle." Darryn J. Reid, and Ralph E. Giffin, "A Woven Web of Guesses, Canto Three: Network Centric Warfare and the Virtuous Revolution," *8th International Command and Control Research & Technology Symposium* (Washington, D.C.: National Defense University, 2003), 2.

[121] Edward Hayward, *Planning Beyond Tactics: Towards a Military Application of the Philosophy of Design in the Formulation of Strategy* (Fort Leavenworth, KS: School of Advanced Military Studies, 2008), 21.

[122] "An *attractor* represents a region of phase space that the system inevitably approaches as it evolves… the attractors of the system harbor important information about certain recurrent aspects of its *long-term behavior*." Ilachinski, *Land Warfare and Complexity, Part II*, 133.

[123] "We can roughly think of an *attractor* as a lake, and the *basin of attraction* as the water drainage flowing into the lake… Under the right conditions, these attractors can be the source of order in large dynamical systems." Kauffman, *At Home in the Universe*, 78.

permanently summons the system down towards the attractor.[124] Thus, maximizing positive

feedback permits the system to escape from this basin of attraction to continue its evolution, most

probably falling into another basin of attraction later in its evolution.

Identification of these attractors during the military transformation process is of relevance

to properly define the desired end state. In every Armed Force there exist recurrent patterns of

behavior and environmental dynamics that act as basins of attraction for the system. Along the

process, the system requires *interventions* to inject energy that permits escape from these basins

and evolve towards the desired end state. Consequently, identification of the desired state for the

military transformation as the basin of attraction to which the Armed Forces desirably have to

evolve, while avoiding those other basins that derail the process, helps define the interventions

needed in the transformational path.

In the face of uncertainty, definition of this basin of attraction as the zone of tolerance

must be the preferred approach to define military transformation, instead of a well-defined,

unambiguous, long-term end state. In addition, the basin of attraction serves as a

multidimensional intellectual construct to help plan and implement the interventions of all sorts

that the transformational process requires to bring the military to the 'desired basin of attraction.'

This approach differs from the traditional-engineering transformational concept that defined the

desired end state mostly in terms of an unequivocal, well-defined, technological solution: the

FCS. Metaphorically, we can consider that a basin of attraction pulled the military out of the

envisioned transformational path, as pure technology solutions could not inject enough energy to

take the system out of the basin. This marked the end of the military transformation as conceived

a decade ago.

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[124] "The boundary between two or more attractors in a dynamical system served as a threshold of a kind that seems to govern so many ordinary processes, from the breaking of materials to the making of decisions. Each attractor in such a system has its basin, as a river has a watershed basin that drains into it. Each basin has a boundary." Gleick, *Chaos: Making a New Science*, 233.

Interestingly, Norman and Kuras, designers of the Air and Space Operations Center (AOCC) for the U.S. Air Force, used complex systems theory to explain their successful use of a regime of *complex systems engineering* (CSE) instead of the traditional systems engineering.[125] Among the different elements that compose the regimen of CSE, they refer to the *'outcome spaces'* as the area of acceptable outcomes for a complex system. This 'outcome space' is composed of multiple specific outcomes, and is produced at multiple levels of scale.[126] This metaphorical but practical construct could also helps define the terms of the end state in military transformation; the 'outcome space' must always encompass the 'specific outcomes' which are produced not only across the different levels of the military, but also in the different agencies and organizations within the same level.

Besides the U.S. Army, other armies have also embraced *adaptability* as their preferred reaction to tackle uncertainty on future's environment. The United Kingdom has recently published guidance for a strategic defense review that considers adaptability as the major feature that the Armed Forces need to adopt to best address future threats.[127] Nevertheless, the Australian Army's concept, 'Adaptive Campaigning', and its proposed 'Adaption Cycle', provide an adequate foundation to propose a new approach to military transformation that echoes the necessity to continually change: 'Adaptive Transformation.'

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[125] See Norman and Kuras, *Engineering Complex Systems.*

[126] "*Outcome spaces* are identified (or defined) at *multiple levels of scale*, and from multiple points of view, for a complex system. An outcome space is explicitly distinguished from the many *specific outcomes* that comprise it… All specific outcomes in the outcome space must be viewed as acceptable without there being strong preferences for any of them." Ibid., 20.

[127] "Against the combined challenges of *uncertainty, affordability and complexity*, we will not be able to develop capabilities against every eventuality…. In particular, we must continue to increase our adaptability, flexibility and agility across Defence in our planning processes, the roles our forces are trained for, our methods of force generation, the equipment we buy and how we buy it." United Kingdom's Ministry of Defence, *Adaptability and Partnership: Issues for the Strategic Defence Review* (London: The Parliamentary Bookshop, 2010), 26.

A Theory on the Design of Military Transformation

Theorizing is an intellectual practice used to convey a particular view on a perceived reality. Essentially, a theory is the proposition of some principles and concepts, and the relationships among them, aiming at explaining a certain subject of interest.[128] Thus, elaboration of a theory is the vehicle to set out the relations among the guiding principles of complex science theory and design, with the purpose of informing the subject of interest of this work: the application of design to define and implement the military transformation. Nevertheless, theory does not provide the definite answer to the subject of interest; it is just an intellectual approach to promote debate and foster future research.[129]

The formulation of a theory for military transformation that exploits the possibilities of complexity theories and design concepts requires *a methodological approach*. Such approach is a must to create *an operable theory* that permits its practical application to the process of planning and implementing a continuous, adaptive transformation process of the military. Consequently, there is a need for a *methodology* that encompasses the broad, theoretical formulations of *philosophy*, with the practical, mechanistic values of *technique.* [130]

As exposed before, the 'Adaption cycle' proposes that learning and adaptation, rather than traditionally-engineered solutions to problems, are the key features to succeed in today's environment. Accordingly, *'Adaptive Transformation,'* rather than the traditional military

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[128] For Hatch, "Theories are built from abstractions known as concepts. One concept–called the *phenomenon of interest* –is selected from all the others as a focus for theorizing and then related concepts are defined and used to explain that one." Consequently, *theory* is "… a set of concepts and the relationships between them proposed to explain the phenomenon of interest." Mary Jo Hatch, *Organization Theory: Modern, Symbolic, and Postmodern Perspectives* (Oxford: Oxford University Press, 2006), 5.

[129] "Theory is better suited to raising important questions at critical moments and reminding you what relevant knowledge is available, than it is to providing ready-made answers to your problems. Use theory as *a tool to help you reason* through complex situations; do not expect it to guarantee your success." Ibid., 10.

[130] "Peter Checkland notes that "while a *technique* tells you 'how' and a *philosophy* tells you 'what,' a *methodology* will contain elements of both 'what' and 'how.'" Banach and Ryan, "The Art of Design: A Design Methodology:" 106.

transformation, is the correct approach to transform the military. Two major postulates inform this model. First, military transformation has to become a *continuous, self-evolving process* of permanent adaptation towards a desired end state. Second, *uncertainty*, as major hallmark of present and future environments, makes it unfeasible to define this end state in unequivocal terms.

The 'Adaption Cycle,' informed by design, is the bedrock of the 'Adaptive Transformation Cycle' that this theory proposes. Both processes intertwine with each other, which permits a multi-layered adaptive approach to a continuous, evolutionary change within the military: the 'Adaptive Transformation.' While the inner 'Adaption Cycle' deals with *operational* issues,[131] the 'Adaptive Transformation Cycle' encompasses the transformational process that affects the overall military organization and deals with *institutional* issues as a whole, including the aspects related to military operations accounted by the 'Adaption Cycle.'

A design methodology allows implementing the 'Adaptive Transformation Cycle.' The tenets of the U.S. Army's design methodology, based on the identification of three different cognitive spaces –environmental, problem, and solution; – and three ways of thinking –divergent, transformational, and convergent, – are accommodated to fit the 'Adaption Cycle' and so facilitate *a multi-scaled design methodology*. Figure 6 represents the coupling of both adaptive cycles.

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[131] In this conceptualization of the 'Adaption Cycle', the term 'operational' does not pertain to the "operational level of war" whatsoever; it refers to all aspects within the military which are directly involved in military operations regardless of their level.
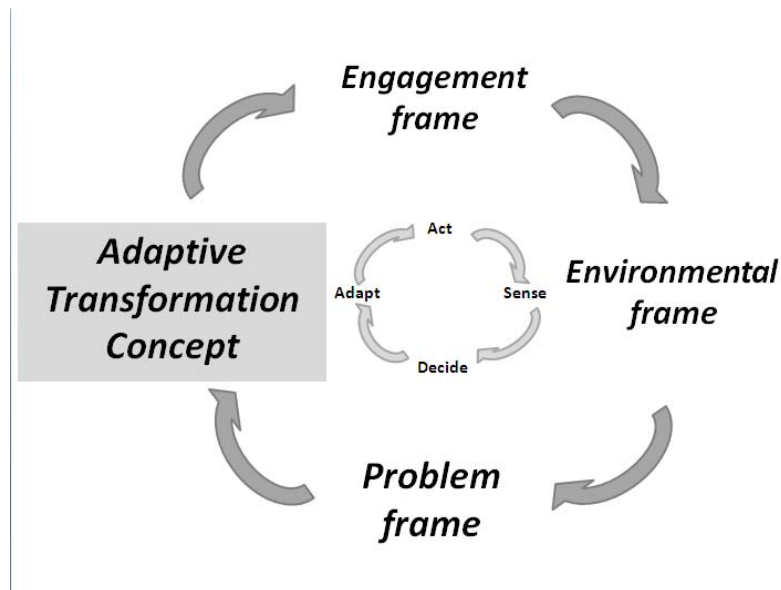
Figure 6. The *Adaptive Transformation Cycle*

Thus, the 'Adaptive Transformation Cycle" encompasses two major processes. An inner cycle accounts for the military operations governed by *operational design* and represented by the 'Adaption Cycle.' Another encompassing cycle represents the overall transformation process at institutional level governed by *transformational design* and represented by the 'Adaptive Transformation Cycle.' The latter is the overarching process that includes operational design. Accordingly, 'Adaptive Transformation' provides a higher level of adaptation informed by design.

Nonetheless, this model necessarily has to recognize *a fourth cognitive space: the engagement space*. This new dimension is where the transformational design process physically and/or cognitively interacts with the environment: political authorities, geography, enemy, public opinion, populace attitude, allies, and media, amongst many others. These interactions do not solely refer to all kind of military operations, within the full spectrum operations concept, that the Armed Forces conduct; they also account for all the wide range of activities that *provoke a response* from the environment within the system, in either material or nonmaterial fashion.

These interactions represent, in a broader sense, the *conduct of operations* at the institutional level that neither starts nor ends the cycle, but that provides the essential stimulus and incentive to keep the 'Adaptive Transformation' running.
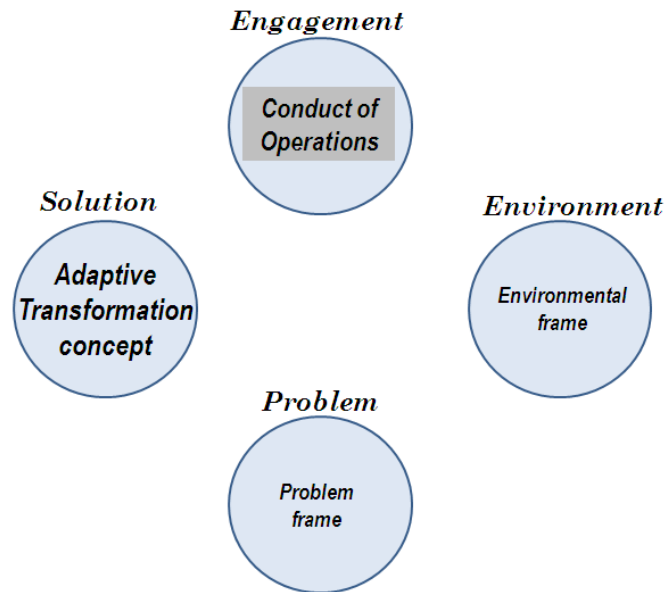

Figure 7. Four cognitive spaces to design the Adaptive Transformation

In sum, the engagement space represents the *"act to influence"* sphere at the institutional level, in correspondence with its equivalent in the inner 'Adaption Cycle' at operations level. *Fundamental surprises* that unexpectedly oblige to reframe the design process and, consequently, lead to a new 'Adaptive Transformation Concept', necessarily occur in this space.[132] This is also the cognitive frame that incorporates *learning* into the design process, which ultimately provides

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[132] For Lanir, *'fundamental surprise'* includes an "element of shock" that distinguishes it from *'situational surprise,'* with early warning systems mostly ineffective. Tzvi Lanir, *Fundamental Surprise* (Tel Aviv: Center for Strategic Studies). See Chapter 2, "The Theory of Fundamental Surprises."

the required adaptability. This is the space where 'Adaptive Transformation' becomes an *operable* concept to effectively achieve military transformation.

Once defined this fourth cognitive space, an actionable concept of Adaptive Transformation becomes feasible. Each of the four cognitive spaces of design at the institutional level that defines the 'Adaptive Transformation Cycle' relates to one step of design at the operations level defined by the 'Adaption Cycle.' (See Figure 6.) The *environmental frame* corresponds with *sense;* the *problem frame* with *decide*; the *solution frame*, or design concept, correspond with *adapt*; in the institutional level it adopts the form of an 'Adaptive Transformation Concept.' Finally, the *conduct of operations* fits with *act;* it represents the operable dimension of design in both the institutional macro-organizational level and the operational level. Design methodology does not conceive these spaces in a sequential manner, but just as a way to organize thinking and actions towards achieving *innovation*, or transformation.[133] These phases not only overlap; they even might occur simultaneously in the design process.

The engagement space, framed through the conduct of operations, can serve to address one of the perceived future challenges for complex systems: the *duality between systems and operations*. This duality pertains to the inadequate relationship between the systems of all type that serves defense purposes and the military operations that are conducted with them; both influence each other in a seemingly uncooperative way.[134] The engagement space that 'Adaptive Transformation' proposes has the potential to provide a new frame that improves an *enhanced cooperative relationship* between the *systems* developed through the transformational process,

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[133] For Brown, "The design process is best described metaphorically as *a system of spaces* rather than a predefined series of orderly steps. The spaces demarcate different sorts of related activities that together form the continuum of *innovation*." Tim Brown, "Design Thinking," *Harward Business Review* (June 2008): 88. He identifies *three spaces* in any design project: inspiration, ideation, and implementation.

[134] "There is a fundamental duality between *systems* and *operations*: systems must be developed in the context of current and future operational requirements, while operations are both constrained and enabled by the systems that have been developed. In spite of this duality, the way defense is currently organized encourages *separation* between operational and systems concerns." Ryan, *Military Applications of Complex Systems*, 45

normally at institutional level, and the *operations* to which they serve. This is the space that allows to make use of the systems in operations, and the frame in which to share learning that helps adapt both systems and operations as needed.

In addition, the 'Adaptive Transformation' concept also recognizes a fourth way of thinking that corresponds with the engagement space: the *interactive thinking*. This is the intellectual approach that is required to plan, implement and assess the myriad of interactions that result within the system. Consequently, the engagement space capitalizes on interactive thinking to maximize these relationships with the environment that, ultimately, are the reason for being of 'Adaptive Transformation' and keep it alive.

This theory does not intent to provide a magic formula or 'recipe book' to solve the military planners' dilemma on Armed Forces transformation. It attempts just to illuminate the contribution that complexity science and Art of Design can offer in their extremely hard endeavor as a valuable intellectual frame to address immanent transformational challenges.

Conclusions and Recommendations

Most defense organizations in the world have adopted the term 'military transformation' to define their long-term evolution towards future forces and capabilities. Despite specificities on resource availability and strategic requirements, many countries have gained inspiration for their transformational processes on the U.S. military transformation. First the Army in 1999 and soon the DOD heartily embraced transformation as the desired approach to face future challenges and threats in the 21st century. Nevertheless, the DOD and U.S. Army concepts for transformation as defined at the turn of the century are currently blurred and emptied of their original meaning. Recent political decisions have discarded the flagship program of the Army's transformation, the FCS. Moreover, the newly issued QDR 2010 mentions the term 'transformation' only twice, and with a much different meaning and scope.[135]

Military planners must consider two major principles to plan and implement a military transformation. First, such transformation represents a process of *radical, comprehensive change* in all aspects of the organization. Second, there is a need for defining a *desired end state* that leads the transformational process in appropriate terms. The U.S. transformation as defined a decade ago seemed to disregard these two aspects to a certain extent. Both DOD and the U.S. Army focused their processes mainly on the technological sphere. Despite some achievements the different fields of the DOTLMPF domain, the materiel approach prevailed and represented the main effort. In addition, the U.S. Army defined the end state in unequivocal, fixed terms, with the achievement of a Future Force principally equipped with the FCS. 'Military transformation' became, in some respect, just an expansion of the RMA that had dominated the defense debate in the 1990s.

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[135] See Department of Defense (DOD), *Quadrennial Defense Review Report* (2010). "The Army is in the midst of a significant *transformation* of its fleet of 70,000 non-tactical vehicles…" (page 87.) In addition, among the high-risk management issues in the U.S. government applied to DOD, one is "approach to business *transformation*" (page 89.) These conceptualizations are clearly out of pace with the QDR 2001 vision for 'transformation.'

Complexity and Art of Design: helping to formulate *Adaptive Transformation*

Is 'military transformation' still a valid concept? 'Adaptive Transformation' is the proposed approach. Any organizational change towards new or refined structures and capabilities inevitably has to account for the *uncertainty* of the future's operational environment. Military planners and decision makers have to face long-term evolutionary changes as a continuously evolving, adaptive process towards an end state defined in terms of a zone of tolerance that accounts for uncertainty. Thus, developing the Armed Forces as a *learning organization* able to continuously *adapt* is a must to succeed in facing future challenges.

Under these premises, 'Adaptive Transformation' can benefit from complex systems theory and design methodology principles. A systemic approach to tackle military transformation needs to recognize the Armed Forces as a *complex adaptive system*. Analysis of key relationships amongst the main agents interacting in the Armed Forces that impact on military transformation is the essential first step. Later, an exploration of applicable elements of *complexity* within the system, like nonlinear interactions, feedback, tradeoffs, attractors, and adaptation, amongst others, offers a useful intellectual approach to address some relevant transformational issues.

Complementarily, the Art of Design provides a methodology that seems ideally conformed to tackle the complex, ill-defined problems that military transformation embodies. Their *social nature* make them 'wicked problems' requiring an Art of Design approach, unlike those *complicated* problems which are suited for a traditional engineered approach. Moreover, the *cognitive spaces* construct that underpins design methodology is an effective way of organizing those critical thinking processes that necessarily have to drive the military planners' endeavors for defining and conducting transformation. The design concept, in the form of a *transformation guideline*, becomes the translation of the designers' intellectual activity into an actionable product that leads subsequent planning and programming to achieve the transformation desired end state.

Nevertheless, this transformation guideline embodies the *military transformation planners' dilemma,* which has to account for the main feature of the future's operational environment: uncertainty. The definition of the end state needs to be broad enough to address uncertainty, but at the same time specific enough to permit detailed programming activities related with structural changes and capability development. The final operable results of this process have to address the entire DOTLMPF domain, with significant modifications of organizations, procedures and resource allocation.

This work offers a theory to help address this dilemma: 'Adaptive Transformation.' An 'Adaptive Transformation Cycle,' based on four cognitive spaces, encompasses at the institutional level the inner 'Adaption Cycle' that functions at the operational level. Thus, both processes are complementary and self-reinforcing in nature, with the former providing a higher level of adaptation informed by design. Nevertheless, the fourth cognitive space, the 'engagement space,' gives meaning to this construct. This dimension represents the institution's physical and/or cognitive interaction with the environment in all its constituent parts.

The 'conduct of operations' in broad sense articulates all the interventions that the system requires to provoke a response and move it forward towards the end state. In addition, in this 'engagement frame' the institution maximizes learning and positive feedbacks to keep the 'Adaptive Transformation' alive. This represents, at the institutional-level, the equivalent to 'act' in the operational level that the 'Adaption Cycle' includes. It also requires a distinct fourth way of thinking, 'interactive thinking,' and a definition of the end state in terms of a 'zone of tolerance' that accounts for uncertainty. A design methodology accommodated to serve the institutional level that exploits the different tools provided by the Art of Design will keep 'Adaptive Transformation' running.

Planning and implementing military transformation: the way ahead

'Adaptive Transformation' constitutes the foundation that enables the application of design to military transformation in order to properly address the evolution of the Armed Forces in the 21st century. This concept benefits from the intellectual and practical resources provided by complex science and the Art of Design. This work concludes with four major recommendations that might help military planners involved in transformational issues in their task.

First, design methodology has military application not only to plan campaigns through operational design, but also to confront other institutional problems like 'military transformation.' The strategic and political decision levels are the authentic realm of design. It is at these levels where problems are really complex. Thus, incorporation of Art of Design *at institutional level*, far beyond its operational applications, will enhance senior leaders' understanding and decision making processes.

Second, military transformation needs conceptualization as a *continuously evolving, self-adapting process*. Developing the military as a learning and adaptive organization is the prerequisite to effectively implement those changes that transformation demands. Although this statement might seem self-evident, it is still an unresolved matter for most of military establishments. Learning to rapidly adapt is the key to succees in the current environment. Thus, a learning structure composed of people, assets, and procedures that effectively captures experiences and thoughts of all sorts and introduces them within the system is a must to implement adaptation.

Third, the *engagement frame* in which the 'Adaptive Transformation' process interacts with the environment and receives feedback requires major attention. Planners for military transformation have to maintain close scrutiny of this environment to properly assess the responses due to interactions, either planned or not. This will permit identifying when and why *reframing* is necessary to address unexpected inputs in the system and reassess the process. Their

role does not finish with the issue of the transformation guideline; this fourth 'engagement frame' is a key component to keep military transformation as a truly adaptive process.

Fourth, the terms used to define its *desired end state* need revision. A snapshot of the current situation that defines an end state for a fifteen-year horizon cannot prevail along the transformational path because multiple unaccounted interventions will affect the process. A 'good solution' in the form of a zone of tolerance or acceptable end state is preferable to an 'optimal solution' that becomes unachievable in the long run.

Consequently, an adaptive approach informed by complex systems theory and the Art of Design must replace the traditional engineering approach in order to define and successfully implement military transformation. Far from providing the key for success, 'Adaptive Transformation' represents an intellectual approach to undertake this arduous task and allow further exploration on how to prepare the military for an unforeseeable and uncertain future.

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